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AMERICAN
DYESTUFF REPORTER

Devoted to Textile Chemistry
BLEACHING • DYEING • PRINTING • FINISHING

OFFICIAL PUBLICATION OF THE PROCEEDINGS AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

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American Association of Textile Chemists and Colorists

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Editor of Proceedings: Carl Z Draves, 30 Lahey St, New Hyde Park, N Y

MAY 10, 1954

AATCC CALENDAR

COUNCIL
1954—June 15, Sept 15, Nov 19.
1955—Jan 21, Apr 15, June 17

NATIONAL CONVENTIONS
Sept 15-18, 1954 (Atlanta Biltmore, Atlanta, Ga); Sept 21-23, 1955 (Chalfonte-Haddon Hall, Atlantic City, N J; 1956 (New York); 1957 (Boston).

HUDSON-MOHAWK SECTION
May 14 (Albany); June 18 (Outing).

MID-WEST SECTION
June 11-13 (Annual Outing—Lake Lawn Lodge, Delavan, Wis).

NEW YORK SECTION
May 14 (Swiss Chalet): June 18 (Outing, North Jersey Country Club, Wayne, N J).

NORTHERN NEW ENGLAND SECTION
June 11 (Outing—Merrimack Valley C C, Methuen, Mass); Oct 8 (Colonial C C, Lynnfield, Mass); Dec 10 (Woodland Golf Club, Auburndale, Mass).

PACIFIC SOUTHWEST SECTION
May 21 (Gourmet Restaurant, Beverly Hills, Calif).

PIEDMONT SECTION
June 11-12 (Outing Mayview Manor, Blowing Rock, N C); Oct 16 (Hotel Barringer, Charlotte, N C).

PHILADELPHIA SECTION
May 21 (Outing—Manufacturers Golf & Country Club, Oreland, Pa); Sept 24, Oct 29 (Penn-Sherwood Hotel, Philadelphia, Pa); Dec 3 (Kugler's Restaurant, Philadelphia)

RHODE ISLAND SECTION
June 11 (Outing—Wannamoisett C C); Oct 14 (Johnson's); Dec 2 (Annual Meeting—Sheraton Biltmore, Providence, R I).

SOUTH CENTRAL SECTION
June 4-5 (Summer Outing — Chattanooga Golf and Country Club); Dec 4 (Hotel Patten, Chattanooga).

SOUTHEASTERN SECTION
May 14-15 (Outing—Radium Springs, Ga); Dec 11 (Atlanta-Biltmore, Atlanta, Ga).

WESTERN NEW ENGLAND SECTION
May 14 (Ladies Night—Waverly Inn, Cheshire, Conn); June 18 (Outing—Chase Country Club, Waterbury, Conn); Oct 1, Nov 12, Dec 10 (Rapp's).

EMPLOYMENT REGISTER

This column is open for two insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the Secretary of the Association, Lowell Textile Institute, Lowell, Mass. It is understood that these will be open to inspection by prospective employers who can obtain further information from the Secretary.

54-7
Education: expecting BS in chemistry and dyeing, Bradford Durfee Technical Inst, June, 1954.
Experience: laboratory technician, three summers, on detergents and dyestuff application.
Age: 21; single; references; position as textile chemist desired; New York area, New Jersey or Connecticut preferred, but not essential. 4-26, 5-10

54-8
Education: expecting BS in chemistry and dyeing, Bradford Durfee Technical Inst, June, 1954.
Experience: two years in print works.
Age: 30; single; veteran; references; position as chemist or dyer desired, location immaterial. 4-26, 5-10

54-9
Education: BS, business administration.
Experience: Control laboratory and dyehouse foreman, rayon.
Age: 36; married; references on request; position in technical sales desired; Southeastern US preferred. 5-10, 5-24

GENERAL CALENDAR

AMERICAN CHEMICAL SOCIETY
National Chemical Exposition—Oct 12-15, Chicago, Ill.

AMERICAN LEATHER CHEMISTS' ASSOCIATION
1954 Convention—June 6, Bedford Spring Hotel, Bedford, Pa.

AMERICAN SOCIETY FOR QUALITY CONTROL
Conference of the Carolinas, Georgia, Tennessee, Birmingham and Huntsville Sections—Nov 5-7, Chattanooga, Tenn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Spring meeting of the Textile Engineering Division—May 21, Hotel Sheraton, Boston, Mass.

AMERICAN SOCIETY FOR TESTING MATERIALS
Annual Meeting—June 13-18, Sherman and Morrison Hotels, Chicago, Ill.

CANADIAN ASSOCIATION OF TEXTILE COLOURISTS AND CHEMISTS
Quebec Section—June 19 (Annual Golf Tournament).

CHAMBRE SYNDICALE TRAMAGRAS
International Detergent Congress—Aug 30-Sept 5, The Sorbonne, Paris, France.

DEUTSCHE GESELLSCHAFT FUR CHEMISCHES APPARATEWESEN
Achema XI—May 14-22, 1955, Frankfurt am Main, Germany.

DRYSALTERS CLUB OF NEW ENGLAND
April 30 (Hotel Vendome, Boston): June 25 (Annual Outing, Wachusett Country Club, West Boylston, Mass).

THE FIBER SOCIETY
Fall Meeting—Sept 13-14, McGill University, Montreal, Canada.

GORDAN RESEARCH CONFERENCES, AAAS
July 12-16, Colby Jr College, New London, N H.

INTERNATIONAL CONGRESS OF MAN-MADE FIBERS
May 31-June 3, Paris, France

PHILADELPHIA TEXTILE INSTITUTE ALUMNI ASSOCIATION
53rd Annual Reunion, June 11, Manufacturers Golf & Country Club, Oreland, Pa.

SOUTHERN TEXTILE EXPOSITION
October 4-9 (Textile Hall, Greenville, S C).

*AATCC Research Newsletter No. 11

NEWS IN GENERAL

American delegates to the ISO conferences in Scarborough, England, next June 4-7 and 12 are W D Appel, L S Little and J A Woodruff. A joint meeting of the sub-committees on colorfastness and shrinkage in laundering of Sectional Committee L-23 of the American Standard Association was held in New York on April 19 to receive official comments and recommendations on the proposed international test procedures, many of which are ready for final consideration as tentative standards. Appel is chairman of L-23, Little is chairman of both sub-committees and Woodruff is delegate-at-large.

Plans for the Symposium on May 19 at the Statler Hotel in New York have been completed and reservations are now being processed. The keynote speaker is J Gordon Dakins, vice-president and general manager of the National Retail Dry Goods Ass'n. His subject – "Textile's Fight for the Consumer's Dollar".

AT RESEARCH HEADQUARTERS

G J Mandikos has developed a new test method, which makes use of the Launder-Ometer metal tubes for determining the dynamic absorption characteristics of water-resistant fabrics. A report will be made to C R Bellwood, chairman of the Committee on Water Resistance, with plans being considered for early publication of the method and binding in the AMERICAN DYESTUFF REPORTER.

Extensive testing on the Accelerotor has been conducted to develop data and information for the Committee on Colorfastness to Washing, which is investigating correlation of Accelerotor results with the 3A Wash Tests and commercial launderings.

The staff attended the first of three lectures given on April 13 at Lowell Technological Institute by Walter J Hamburger on "Some Aspects of the Engineering Design of Textiles".

R H Wingate, Chairman of the Committee on Wearing Apparel of the National Fire Protection Association; Chester Babcock, also of NFPA; and Arthur Spiegelman, of the Board of Fire Underwriters, New York City, were recent visitors to AATCC Headquarters in Lowell. Following a tour of the laboratories considerable time was spent discussing the current flammability situation and the interlaboratory testing program of the National Bureau of Standards and the Laboratory of the California State Fire Marshal.

AATCC was host to more distant visitors recently in a tour of the laboratories given Saichi Morimoto of Toyo Spinning Co and S Inoue of Toyo Boseki Co, Ltd, accompanied by David Kaye of Transocean Commerce, Inc, New York City.

COMMITTEE NEWS

The Committee on Colorfastness to Fulling has submitted a new testing procedure which provides a means of introducing increased mechanical friction and of temperature variations (to compensate for the rise in temperature which occurs in long duration mill fulling). The method is being circulated to the Technical Committee on Research and it is hoped that it may be approved as a tentative test in time for inclusion in the 1954 Year Book.

The Continuous Wool Scouring Committee has a new test method for "Determination of Spinning Lubricant Scourability". A paper on this work appeared in ADR of April 26. The procedure has been submitted to the Executive Committee on Research for its acceptance as a tentative standard.

Earl S Dunlap, Lehigh Dyeing and Finishing Company, has accepted membership on the Committees on Colorfastness to Washing and Light.

H W Wolf of the Garfield Laboratories of Forstmann Woolen Co has been elected Chairman of the Committee on Analysis of Fiber Mixtures.

* Published every other issue of the AMERICAN DYESTUFF REPORTER.

MEMBERSHIP APPLICATIONS

SENIOR

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Richard E Brannon—General manager, Armtex, Inc, Pilot Mountain, N C. Sponsors: J A Kidd, R F Morris, Jr.

Hamilton I DePass—Southern representative, Verona Dyestuffs, Rock Hill, S C. Sponsors: R S Spencer, W P Clement.

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Howard L Edwards — Laboratory mgr, Bibb Mfg Co, Macon, Ga. Sponsors: C Mueller, D B Ekstrom, Jr.

Richard R Frey — Assistant secretary, AATCC, Lowell, Mass. Sponsors: E E Fickett, H C Chapin.

John J Gallagher—Dyer, Oxford Textile & Finishing Co, Oxford, N J. Sponsors: R E LeCompte, B Comerro.

Edward G Hansen—Dyer, Sanco Piece Dye Works, Phillipsburg, N J. Sponsors: B Comerro, R E LeCompte.

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Michael London—Assistant editor, dyeing and finishing, "Textile World", New York, N Y. Sponsors: C N Rabold, J H Kennedy, III.

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Peter L Martese—Chemist, E I du Pont de Nemours & Co, Inc, Wilmington, Del. Sponsors: J E Smith, C A Sylvester.

Hisham M Pharaon—Technician & colorist, Moussa R Pharaon's Mill, Amman, Jordan. Sponsors: C Z Draves, L Fusser.

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George Wenzel—Chemist & colorist, asst treasurer, North American Dye Corp, Danbury, Conn. Sponsors: W H Espelin, R J Carey.

Hans C Wirth—Asst tech mgr, Vereinigte Farbereien & Appretur, Zurich, Switzerland. Sponsors: W G Helmus, H Moore.

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H Conrad Harvey—District mgr, "Textile World", Philadelphia, Pa.

George Isherwood—Representative, "Textile Industries", Atlanta, Ga.

James MacDonald, Jr—Textile engineer, E-Z Mills, Inc, Cartersville, Ga.

Ferdinando A Mancini — Sales manager, Rock SRL, Milan, Italy.

J R Pruett—Plant manager, Textiles Panamericanos S A, Medellin, Colombia.

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APPLICATION FOR TRANSFER TO SENIOR MEMBERSHIP

V S Kulkarni
Francisco C Mauri

THE APPLICATION OF VAT DYES

Monograph No. 2 of the

American Association of Textile Chemists and Colorists

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"This monograph contains the work of many mill-experienced authors, plus good, sound chemical and application principles developed in the laboratories and mills enjoying AATCC membership. . . . This book puts between two covers much information that a dyer is constantly searching for. It is a good investment for any laboratory, dyehouse, or printshop."—*TEXTILE WORLD*.

". . . this monograph should be in the hands of every user of vat dyestuffs, every student and every teacher. The book is well indexed and includes valuable lists of equivalent trade names. It will certainly take its place as a standard book of reference".—*JOURNAL OF THE SOCIETY OF DYERS AND COLOURISTS* (England).

The price of "The Application of Vat Dyes" is $5 per copy, postpaid, to members; to nonmembers it is $6 per copy. Send your check or money order to the

SECRETARY AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

P O BOX 28, LOWELL, MASSACHUSETTS

1953 Annual Convention——"Science Fibers" Session——

DYNEL "INNER STRUCTURE"*

T A FEILD, JR, C A SETTERSTROM, and C W DAVISSON

Textile Fibers Dept, Carbide and Carbon Chemicals Company
A division of Union Carbide and Carbon Corp, New York, N Y

INTRODUCTION

THE term Dynel "Inner Structure" was born when a research worker dissolved the rayon from a creased fabric prepared from stock-blended Dynel and rayon, disclosing the sheer but tough and sharply creased Dynel skeleton. It was apparent at once that here was more than just a residue; here was a perfectly formed fabric, hidden by the bulk of the other fiber, but imparting crease retention and wrinkle resistance to the blend. The name Dynel "Inner Structure" seemed the natural description for this hidden framework of the fabric.

The revelation of the Dynel "Inner Structure" immediately stimulated the imaginations of technologists in research, technical service, and sales. Could a study of "Inner Structures" disclose effectiveness of union dyeing? Could it show which fiber in a blend resulted in poor light fastness? Could it show the contribution of each fiber to the character of the fabric? Could it show the effects of various resin treatments on each component of the blend? Could it disclose damage due to ironing or excessive heat? And could not the Dynel "Inner Structure" form the basis for a new method of education to illustrate the crease retention and wrinkle resistance afforded by a relatively small proportion of hydrophobic fiber?

Subsequent studies showed that all of these questions could be answered affirmatively. In fact, these were only a few of the questions answered by this technique. Here was a fundamental tool of interest to technologists and salesmen in the mills and dye houses, to converters, cutters, retailers, and consumers.

It is the purpose of this paper to present some of the more interesting uses found for "Inner Structure"; and to provide procedures for deriving the Dynel "Inner Structures" from blends with wool, the cellulosic fibers, and nylon. No claim to originality is professed for the development of "Inner Structure" techniques; novelty fabrics have been produced for years by dissolving one fiber from a blend with another *(1, 2, 3, 4)*; and other research workers, notably at the Army Research and Development Laboratories, Philadelphia Quartermaster Depot *(5)*, have prepared "single fiber structures", photographs of which they termed, "Skeleprints".

C A Setterstrom

The isolation of each of the separate fiber structures in a fabric prepared from two or more stock-blended fibers has proved a useful tool for determining the influence of each fiber on dimensional stability, color, lightfastness, uniformity of blending, damage from excessive heat, abrasion, loft, and pleat retention of the original fabric.

Methods for preparing inner structures of Dynel and other fibers are detailed, and the adaptability of the technique to a wide range of fiber blends is suggested.

DISCUSSION

It will be attempted, in the discussion which follows, to suggest uses for "Inner Structures" which will be applicable to yarns or fabrics composed of any combination of fibers. Blends of certain fibers may require considerable ingenuity in their separation; particularly where original shade and lightfastness must be retained by the "Inner Structure". The exceptional chemical inertness of Dynel, and the wide difference in solvents required to dissolve this fiber and the natural and cellulosic fibers have adapted the Dynel blends well to "Inner Structure" techniques. Only Dynel - acetate blends are troublesome; acetate can be removed from the Dynel, but the Dynel can not be removed from the acetate by any method now known.

FIBER DISTRIBUTION——One of the first uses to become apparent for "Inner Structures" was that of determining uniformity of fiber distribution in the blended yarns of a fabric. Uniformity is detected by holding the "Inner Structure" before a source of light and viewing the light transmitted by the specimen. The technique should be adaptable to fabrics and to yarns blended of nearly any combination of fibers.

It is fitting, here, to pay tribute to the technology of today's spinning industry. Nearly every "Inner Structure" prepared to date from a finished fabric has shown excellent fiber distribution; and the fabrics tested have contained blended yarns spun at many cotton, worsted, and woolen mills throughout the United States and abroad.

UNION DYEING —— How many times have you wished to see the components of a union-dyed blended fabric? This is often desirable in matching a solid color, and may be a necessity in matching a blend where the components are colored differently. "Flags" or "telltales" representative of the components have been employed through the years in union dyeing, but frequently differences in fiber stock, or differences in pretreatments given the blended fabric and the telltale fabric result in discrepancies. "Inner Structures" taken from the blended fabric largely eliminate this source of error. The hydrophobic Dynel, dyed with any type of dyestuff, will in most cases be unaffected by the concentrated acid, alkali, or hypochlorite required to dissolve the hydrophilic fiber of the blend; and the Dynel "Inner Structure" will display the color it had in the blend. Similarly, the hydrophilic, natural and viscose fibers appear in most cases to be unaffected by cold dimethylformamide. Extraction of Dynel with this reagent will leave the hydrophilic structure of the blend with the same color it had in the blend. This method has been used successfully on bleached blends of Dynel and hydrophilic fibers, also. Figure 1 depicts the Dynel and wool "Inner Structures" of a blended plaid fabric.

LIGHT FASTNESS —— When a blended fabric fades off tone in the Fade-Ometer or in sunlight, it is usually difficult to know which fiber is at fault. "Inner

* Presented by C A Setterstrom in the Conrad Hilton Hotel on Sept 17, 1953. Submitted to the Reporter by the Editor of Proceedings on March 15, 1954.

† Dynel is Union Carbide's new science fiber.

Structure" methods have been most helpful in solving this problem. "Inner Structures" may be prepared either before or after exposure of the test specimen. Figure 2 is a photograph of an exposed specimen of a Dynel and wool blended fabric together with a similarly exposed specimen of the wool "Inner Structure". In this case, the wool shows better light fastness than that of the blend.

PHYSICAL PROPERTIES ——— The determination of the contributions of the various fibers in blends to the physical characteristics of the blend is a worthwhile application for "Inner Structures". This appeared practical after it was found that the concentrated acids and alkalis required for elimination of the natural and cellulosic fibers had no residual effect upon shrinkage or strength of the Dynel.

One important physical property of a blend is its fiber composition: How much Dynel? How much rayon or wool? The methods later to be described for obtaining "Inner Structures" are quantitative in their yield of the fiber composing the "Inner Structures", and, with due care in sample preparation, conditioning, and weighing, will provide quantitative analysis of the blend. Figure 3 illustrates this quantitative separation by showing a piece of blended fabric suspended from the hook on the left side of a balance beam and balancing its "Inner Structures", which are suspended from the hook on the right side of the balance.

Another physical property of importance is dimensional stability. The "Inner Structures" removed from a piece of greige fabric may be employed to obtain single fibers, stability of which may be compared with that of fibers from "Inner Structures" of dyed fabrics or of dyed and resin-treated fabrics. A more direct method is to mark pieces of fabric or yarn dimensionally and then remove the "Inner Structures". Dimensions are best indicated by single loops of thread: Dynel, when the Dynel "Inner Structure" is to be obtained, or cotton, when the natural or cellulosic structure is to be obtained. This direct method is illustrated in Figure 4, 5, and 6, in which specimen layout, measurement, and solvent extraction are depicted.

The results from direct determinations of dimensional changes on "Inner Structures" must be considered thoughtfully before conclusions are drawn. It must be realized that the removal of the bulk of one fiber leaves considerable space between the fibers of the yarns composing the "Inner Structure". Subsequent shrinkage of this structure may be three-dimensional: cross-sectional area of the yarn and length alike are subject to shrinkage. This explains unidimensional shrinkages of the "Inner Structures", which appear

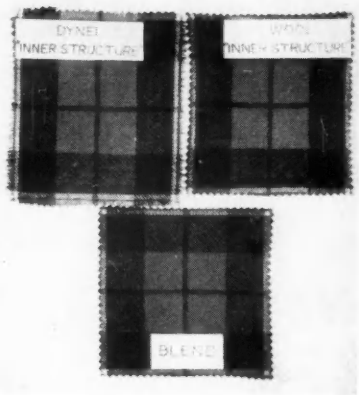
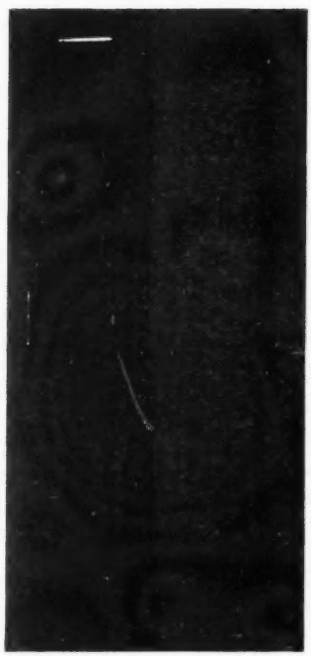


Figure 1
Value of "Inner Structures" in Shade Matching



Left: "Inner Structure"
Right: Blend

Figure 2
Value of "Inner Structure" in Measuring Light Fastness

lower than might be expected from shrinkage of the blend. Disproportionately reduced fabric strength would be expected of the "Inner Structures", particularly of the one representing the lower quantity of fiber; this has been demonstrated to be true, and is mentioned here to support the concept of "bulk factor" and three-dimensional shrinkage. The strength of the blend, particularly the wet strength, is improved by Dynel.

The unusual finding that the Dynel "Inner Structure" is generally wider and longer than the blended fabric from which it came may be explained on the basis of "bulk factor". In a special case where a very tightly felted Dynel-wool fabric was sought through the use of swelling agents for the Dynel, it was found that the Dynel "Inner Structure" was considerably shorter and narrower than the blend from which it was obtained. This probably resulted from stresses set up in the Dynel by the swelling agent, which could not be released until the wool was removed.

The value of "Inner Structure" techniques in the study of dimensional stability is shown by this example: An experimental resin-treated Dynel-rayon-acetate-blended fabric was found to shrink 10 percent fillingwise after prolonged wash testing. Comparison of the shrinkages of the Dynel "Inner Structures" of the resin-treated fabric and the untreated original fabric showed a fillingwise difference of 11 percent. It was learned that the fabric had been drawn out 11 percent fillingwise during the resin cure. This and similar data indicate that resin treatments must be conducted without tension if dimensional stability is to be obtained in the fabric.

Typical dimensional stability data obtained from "Inner Structures" in the laboratory are shown graphically in Figures 7, 8, and 9.

Figure 7 shows the "Inner Structure" study of a blend containing 25 percent Dynel, 25 percent acetate, and 50 percent rayon. The group of curves designated "A" was obtained from the fabric after stabilization. The group of curves designated "B" was from the same fabric prior to finishing and not processed to relieve the strains in the Dynel which were imparted during the yarn and fabric manufacture. Resin treatments were not employed with either of these fabrics. The contribution of strained Dynel to fabric instability is illustrated in the "B" group of curves for the unfinished fabric. The excellent stability of correctly processed Dynel and its contribution to the blend are evident in the "A" group of curves for the properly finished fabric.

The steaming and sponging tests employed to measure the dimensional stabilities are adaptations of "Procedure for Determination of Relaxation or Sponging Shrinkage", Tentative Test Method 41-49, AATCC *(6)*. "Steaming" comprises the blowing of steam up through *dry* fabric from the buck of a Hoffman flat-bed press for specific time intervals; "sponging" comprises pressing of the *damp* fabric to dryness, employing specific time intervals of press closure.

Figure 8 illustrates the tendency for the rayon "Inner Structure" to *increase* its dimensions when measured wet. This unusual phenomenon has been observed on all rayon "Inner Structures" tested,

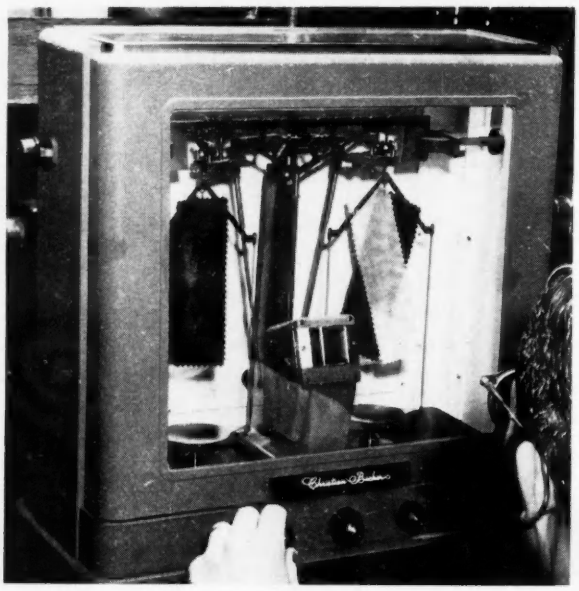


Figure 3
Quantitative Separation of
"Inner Structures" from the Blend

Figure 4
Layout of Specimens for
Stability Tests

Figure 5
Measurement of Fabric
for Stability Tests

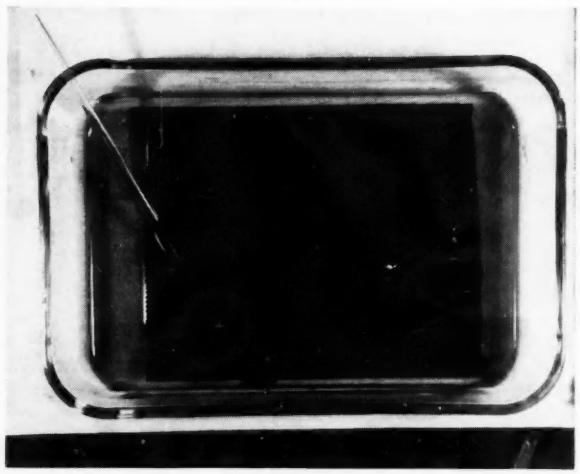


Figure 6
Preparation of "Inner Structures"
for Stability Tests

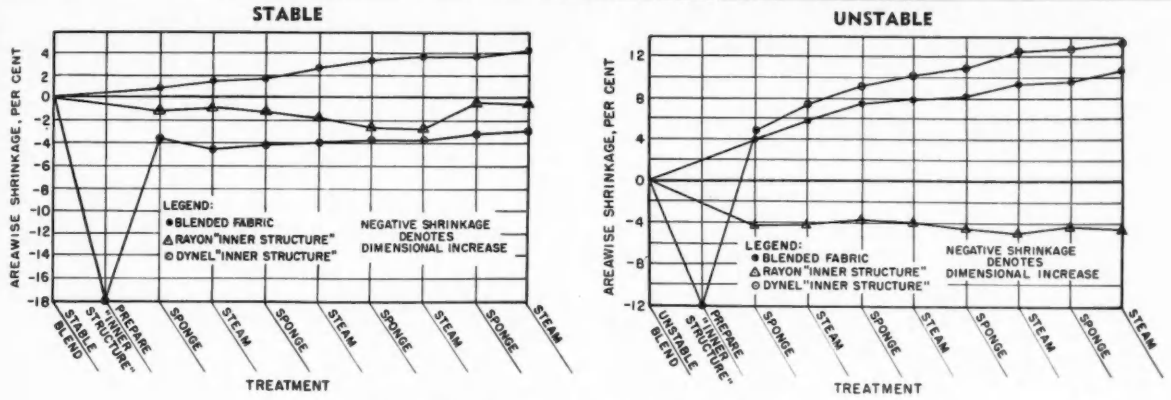
resin-treated or otherwise. Other laboratories have observed the tendency of all-rayon fabrics to "grow" when wet (*7*). The desirability of having the hydrophobic fiber present in a rayon garment is readily seen: baggy knees and elbows which might otherwise occur on damp days will be prevented by the presence of the nonswelling fiber.

Figure 9 shows the good dimensional stability shown by a typical Dynel-wool blend and the "Inner Structures" of the blend.

Ironing temperature is a physical characteristic of a blend which may be studied by the use of "Inner Structures". The safe ironing temperature for all-Dynel fabrics is 275°F. Cotton, rayon, and wool bestow protection against local glazing and permit ironing temperatures of 320°F and higher, which correspond to the rayon setting on electric irons. If complaints of color changes due to ironing arise, "Inner Structure" techniques are valuable to show which fiber is to blame; it is not always the thermoplastic fiber. Figure 10A and 10B show "Inner Structure" tests made on a Dynel-rayon-acetate fabric which had been treated with Hydropruf "A" silicone water repellent. This treatment raised the safe ironing temperature of this fabric to 220°C (428°F). The Dynel "Inner Structure" shows a color change at 230°C, as shown in Figure 10B.

Study of the physical characteristics of blended blankets has involved "Inner Structure". Figure 11A shows the "Inner Structures" derived from a 50-50 Dynel-wool blanket and a piece of the original blanket. Figure 11B shows the same piece after scouring. That Dynel prevented shrinkage is obvious. The porous, resilient form of the hydrophobic "Inner Structure" is explanation enough for the rapid-drying characteristics of these blended blankets.

Another physical characteristic of blends



(Blended fabric contained 25-25-50 Dyne'-acetate-rayon)

Figure 7

An "Inner Structure" Study of Dimensional Stability

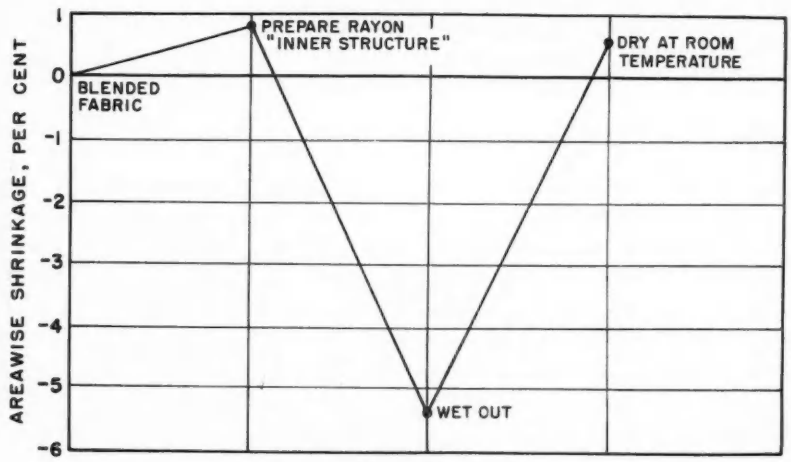


Figure 8
Behavior of a Rayon "Inner Structure" When Wet Out

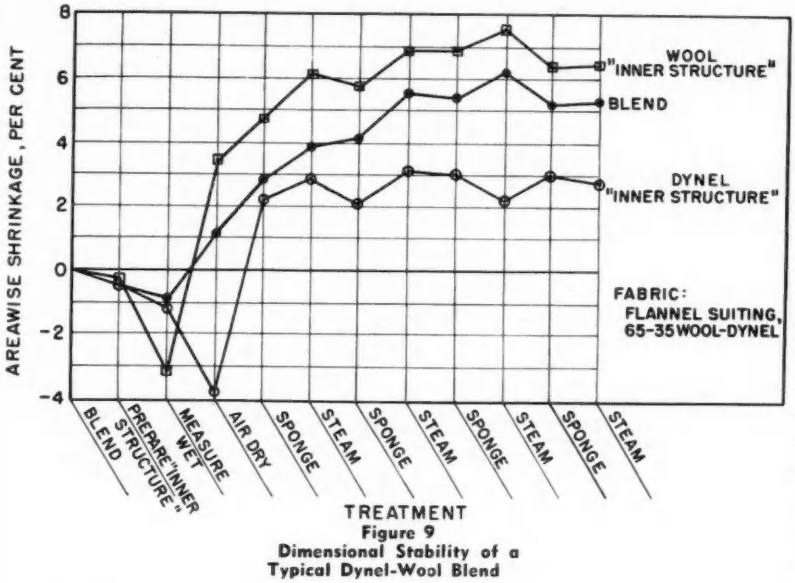


Figure 9
Dimensional Stability of a Typical Dynel-Wool Blend

for which "Inner Structure" methods are useful is abrasion resistance. The phenomenon of pilling, which occurs prior to failure of the abraded specimen, is particularly adaptable to study: three specimens of a blend may be abraded to a point short of failure by a method such as the Stoll flex abrasion test. All three may show pilling. Two of the specimens are then converted to the "Inner Structures" of the blend, and that "Inner Structure" which retains the "pill" is deemed responsible. Figure 12 illustrates this type of study on a Dynel-wool blend. It will be noted that the "pill" is retained by the wool "Inner Structure", and that no long fibers protrude from the abraded portion of the Dynel "Inner Structure", which is therefore not responsible for pilling.

CHEMICAL PROPERTIES —— The chemical resistance of Dynel to inorganic acids and bases is well known. Similarly, good resistance to most organic solvents is shown. Marked swelling and fiber degradation may result in Dynel from certain agents, such as certain ketones, certain aldehydes, concentrated formic and acetic acids, and liquid sulfur dioxide. The more common shrink-proofing or wrinkle-proofing resins for rayons and cottons, such as the urea-formaldehyde resin, appear innocuous to Dynel. "Inner Structure" studies have shown, however, that resin treatments with unknown ingredients may cause unusual changes in the Dynel. After one unknown resin treatment, the Dynel "Inner Structure" was found darkened in color and harsh in hand; the individual yarn strands were quite weak and brittle with microscopic evidence of solvent action. Such a resin treatment may defeat the purpose of having Dynel in the blended fabric.

One chemical treatment of a Dynel-rayon-acetate blend resulted in a con-

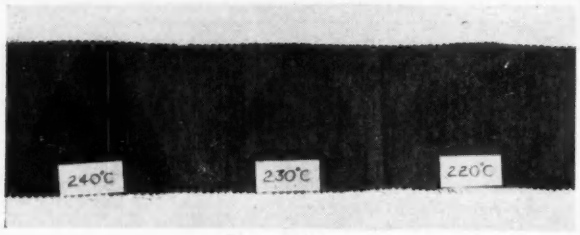


Figure 10A
Color Change Due to Ironing in a Dynel-Rayon-Acetate Blend

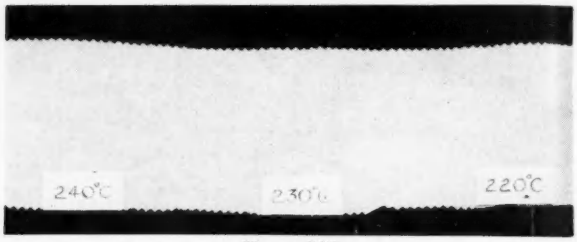


Figure 10B
Color Change Due to Ironing in a Dynel "Inner Structure"

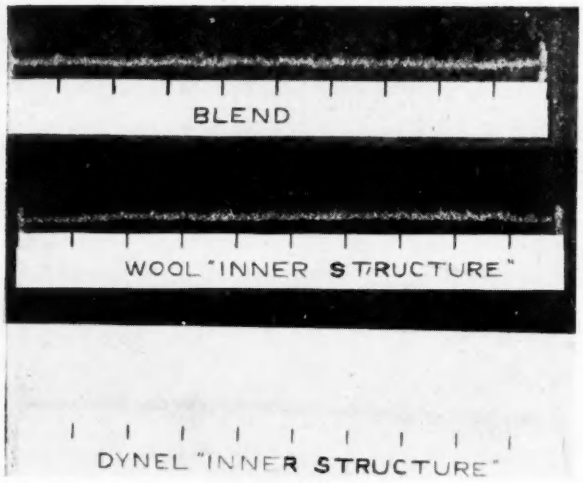


Figure 11A
Blanket and "Inner Structures" Before Scouring

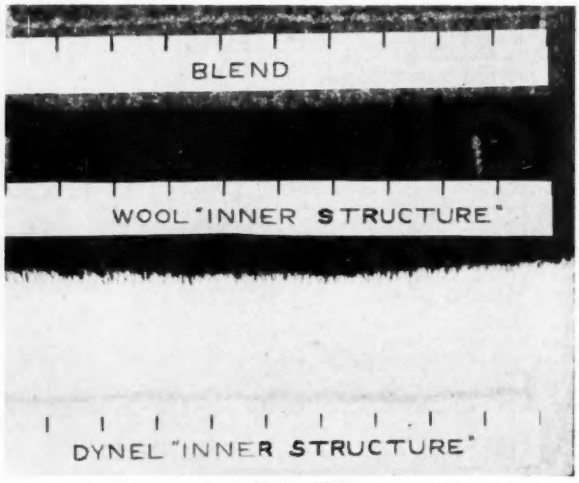


Figure 11B
Blanket and "Inner Structures" After Scouring

siderable raising of the safe ironing temperature of the Dynel and materially reduced its solubility in acetone and dimethylformamide. This was discovered by "Inner Structure" methods. The agent was Hydropruf "A" silicone water-repellent finish.

Considerable work is in progress to evaluate the effects of various shrink-proofing and wrinkle-proofing chemical treatments applied to blends of Dynel with cellulosic fibers. At present it appears that the hydrophobic fiber is sufficient on its own to provide crease retention. More data are needed to show the contribution of the hydrophobic fiber to wrinkle resistance. To avoid shrinkage due to the swelling of the rayon *(9)*, a chemical shrink-proofing treatment may be very helpful. Such application should be made to relaxed fabric to avoid putting strains into the hydrophobic fibers, which will result in shrinkage during subsequent pressing treatments.

The customer-service technologist views with mixed emotions the discovery that the blend problem which has worried him for a week is really not his problem; that his own fiber is not even represented in the blend! Improper labeling of fabrics

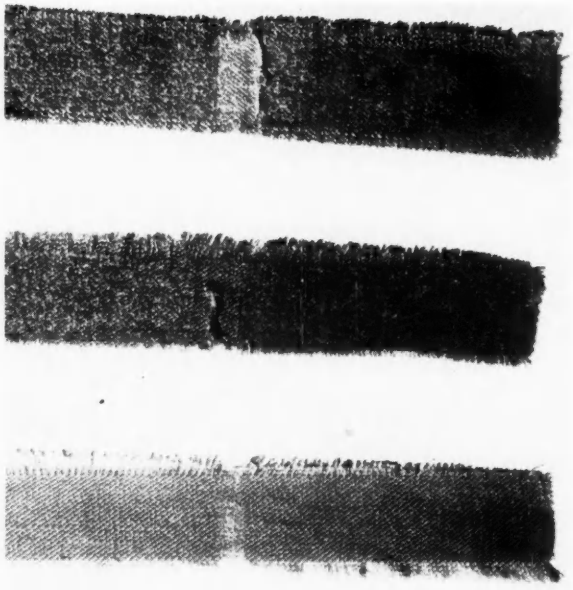


Figure 12
A Study of Pilling, Based on "Inner Structures"

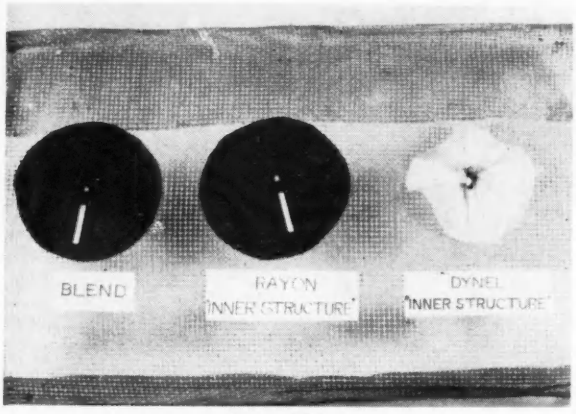


Figure 13A
Ignition of Dynel-Rayon Blend and Its "Inner Structures"

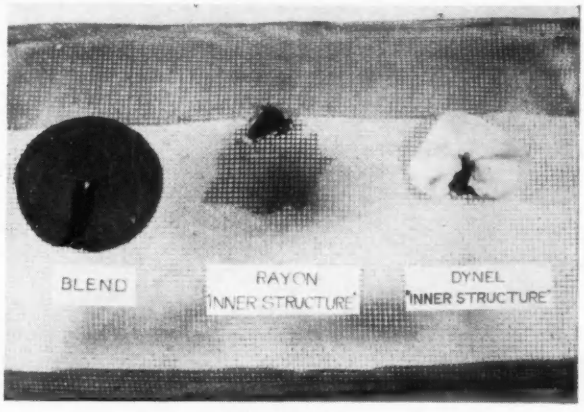


Figure 13B
Extent of Burning of Dynel-Rayon Blend and Its "Inner Structures"

is rare, but "Inner Structure" techniques have uncovered such mistakes. Identification stains and chemical solvation methods, such as those described in a recent Du Pont Technical Bulletin *(8)*, may be used to determine the unknown fiber.

FIRE RESISTANCE——The fire resistance conferred by the Dynel "Inner Structure" of a 30-70 Dynel-rayon fabric is illustrated by the simple match test in Figures 13A and 13B.

It will be noted that propagation of the fire is great in the rayon, very low in the blend, and least in the Dynel "Inner Structure", which became wrinkled in the attempt to shrink away from the flames. The extent of damage to blends due to flame will vary with different fabric constructions and weights. Dynel flames while held in a flame, but goes out instantly, without dripping or afterglow, when the flame is removed.

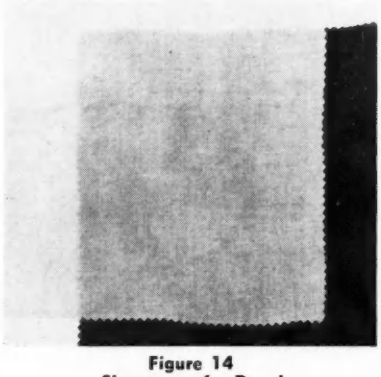


Figure 14
Sheerness of a Dynel "Inner Structure"

NOVELTY FABRICS——Dynel "Inner Structures" taken from inexpensive, plain-woven, Dynel-rayon fabrics may be of interest as fine screen-print cloths. Strength, resilience, and uniformity of these fabrics is good, and the process for their removal is simple. The sheerness of the Dynel "Inner Structure" is illustrated in Figure 14, where the shadow of the blended fabric shows through the Dynel "Inner Structure".

Another possibility for the use of Dynel "Inner Structures" in novelty fabrics lies in the hot calendering of blended fabric followed by separation of the Dynel "Inner Structure" to produce very sheer fabrics with unusual strength, handle, and appearance.

EDUCATIONAL——The excellent crease retention afforded by hydrophobic "Inner Structures" of fabrics may be illustrated readily. Figure 15A shows a pleated fabric blended of 65 percent wool and 35 percent Dynel, together with the wool and Dynel "Inner Structures". Figure 15B shows the same fabrics after

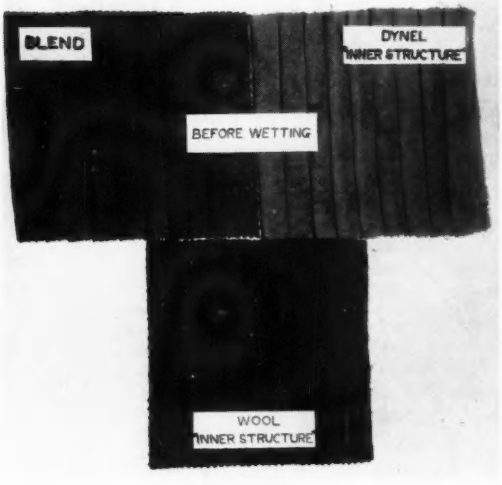


Figure 15A
Pleated Specimens Before Wetting Out

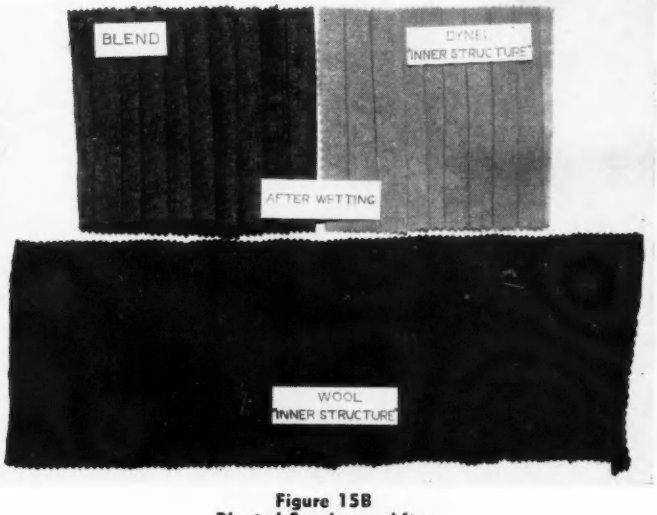


Figure 15B
Pleated Specimens After Wetting Out

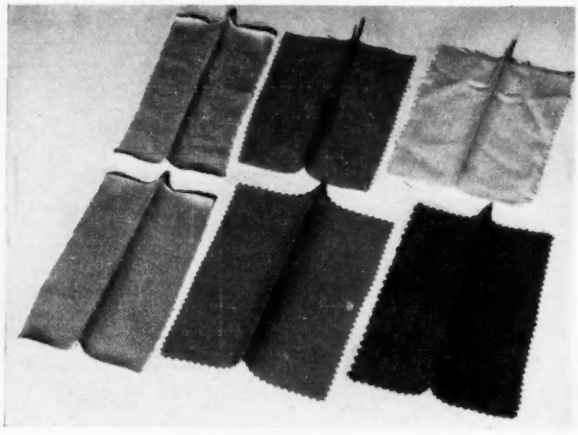


Figure 16
Effect of Fabric Thickness
on Sharpness of Crease

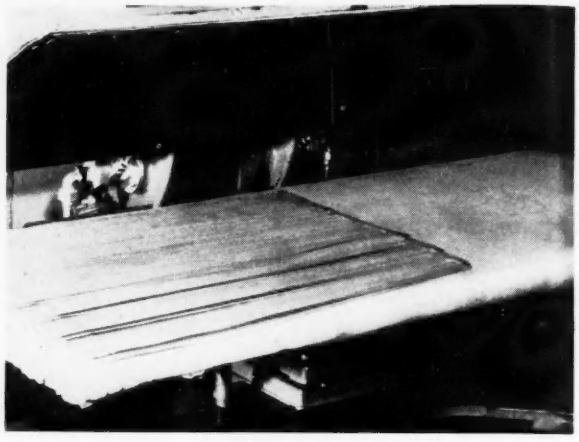


Figure 17
Pressing the Pleats
into a Blended Fabric

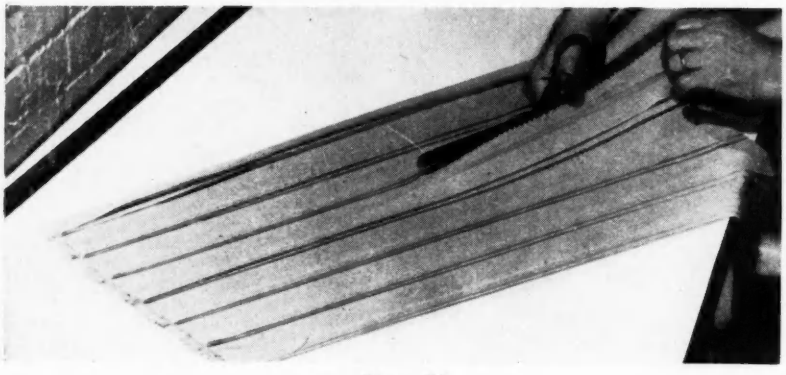


Figure 18
Cutting of the Pleated
Blend

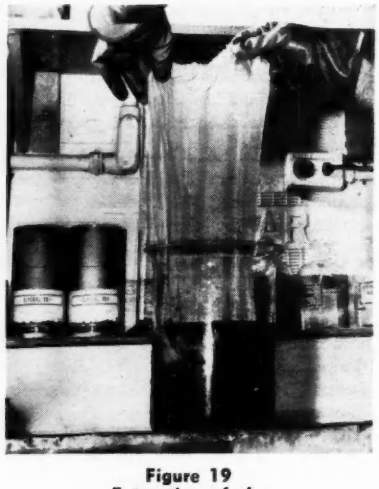


Figure 19
Extraction of the
Rayon from the Blend

wetting out. Crease retention by the blend and the Dynel "Inner Structure" are obvious.

It will be found that the sharpness of crease of the Dynel "Inner Structure" is inversely proportional to thickness of fabric. This indicates that higher pressures are required to press the thicker fabrics. Figure 16 provides a comparison between the sharp creases of a tropical worsted blend and a winter herringbone fabric and the more rounded crease of a thicker fabric.

Such demonstrations can be important educational aids for both the trade and the consumer. By making it possible to see the actual contributions of each fiber, much of the mystery, uncertainty, and excessive claims for fabric blends can be dissipated; true merit can be clearly illustrated.

As the complexity of fabrics increases, the technologist should assume a leading role in consumer education. He must do all he can to develop interesting and factual educational techniques for the sales department. The "Inner Structure" presentation is one such technique.

EXPERIMENTAL PROCEDURE

MAKING "INNER STRUCTURES" ———The Dynel "Inner Structure" is obtained from a blend with cellulosic fibers by using 70 percent sulfuric acid. In the laboratory, the fabric is immersed in a considerable excess of acid solution to insure quantitative results: usually about two liters per square foot of fabric. The first immersion is for 60 minutes. The solution is then decanted and a fresh acid solution is entered. Time in the second bath is 30 minutes. Immersion at room temperature serves to remove rayons; a temperature of 120°F is employed to remove cotton. The "Inner Structure" is rinsed several times in cold water and placed on a towel to dry. Figures 17 through 21 illustrate the preparation of the Dynel "Inner Structure" from a section of a pleated Dynel-rayon fabric. Figure 22 demonstrates the sharpness of the retained pleats of the Dynel "Inner Structure".

The Dynel "Inner Structure" is prepared from a blend with wool by using Clorox bleach. The blend is immersed in a 50-75:1 bath of Clorox at 0-10°C (32-50°F) for a period of 30 minutes. The temperature of the bath is then permitted to rise to 30° C (86°F), but not over 35°C (95°F), and is maintained at that temperature for 30 minutes. The Dynel "Inner Structure" is thoroughly rinsed in cold water and placed on a towel to dry.

The Dynel "Inner Structure" may be obtained from a blend with nylon with a 20 percent solution of hydrochloric acid, which may be warmed to 120°F to hasten the decomposition of the nylon. Two extractions with fresh portions of the acid are employed, followed by thorough rinsing of the Dynel "Inner Structure" in cool water.

Dynel may be removed from the other fibers, except for acetate, by soaking in acetone at 110° to 120°F for one hour, followed by two rinses in fresh, warm

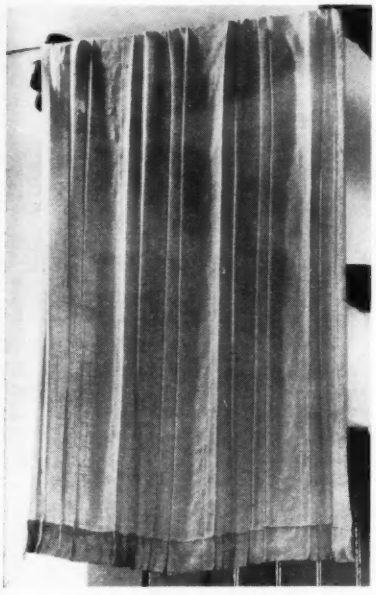
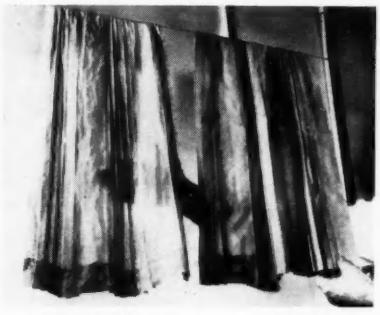


Figure 20
A "Close Up" of the Dynel "Inner Structure"

acetone. Dimethylformamide can be used instead of acetone and can be used at room temperature.

"Inner Structures" which are to be measured for dimensional change are obtained with the sample specimens lying flat. A 12 by 18-inch Pyrex baking dish permits removal of the soluble component from a 12 by 12-inch blended specimen with a minimum of fabric distortion. Two liters of the solvent solution, usually dimethylformamide, sulfuric acid, or Clorox, are poured slowly down the side of the baking dish and over the fabric. The fabric is held down by several 8-inch lengths of 10-mm glass rod, and agitation is provided by rolling these rods back and forth across the face of the fabric by means of a glass stirring rod. Following extraction, the solvent is carefully decanted from the fabric. Figure 6 is illustrative of the preparation of "Inner Structures" for dimensional purposes.

Caution must be observed in handling the solvents specified. Goggles should be worn when handling any of the agents. Flames must be kept from the acetone or dimethylformamide. Acids must be poured slowly into cold water; never pour water into acid! Stainless steel must not be used with sulfuric acid.



Dynel "15" Blend

Figure 21
Drying of the Pleated Fabrics

SUMMARY

The term "Inner Structure" has been defined and we have shown how "Inner Structure" may be prepared and used. It has also been shown that "Inner Structures" are a valuable tool to the technologist who is concerned with spinning, weaving, dyeing, bleaching, and finishing. A few examples of the data obtained from studies of "Inner Structures" in the laboratories of Carbide and Carbon Chemicals Company have been presented. These studies are continuing, and much more fundamental information is expected to result.

While methods for separating all fiber blends are beyond the scope of this paper, it is the hope of the authors that the "Inner Structure" approach will prove a challenging new research tool for studying the properties of all fabrics from blended fibers.

REFERENCES

(1) Urquhart, A R, Hegan, H J, and Loasby, G, *The Development of Some Man-Made Fibres*, p 67, Manchester: The Textile Institute (1952).

(2) Midgley, E, *The Finishing of Woven Fabrics*, p 372, New York: Longmans, Green, and Company (1929).

(3) Hottenrath, V, *Artificial Silk*, p 372, London: Sir Isaac Pitman and Sons, Ltd (1928).

(4) *Review of Textile Progress* III, p 255 and p 307, Manchester: The Textile Institute; and Bradford: The Society of Dyers and Colourists (1951), (p 255 and p 307).

(5) Letter: John C Hintermaier, Textile Materials Engineering Laboratory, Research and Development Laboratories, Philadelphia Quartermaster Depot, U S Army, to T A Feild, Jr, Union Carbide and Carbon Corporation, South Charleston, West Virginia, dated March 10, 1953.

Figure 22
Beauty of the Dynel "Inner Structure"

(6) 1952 *Technical Manual and Year Book*, *AATCC* XXVIII, New York: Howes Publishing Co, Inc.

(7) Welch, I H and Woodruff, J A, "Avcoset Stabilization of Rayon Fabrics", *Am Dyestuff Reptr* 41, P881 (1952).

(8) "Identification of Fibers", *DuPont Technical Bull* 8, #4, 192 (1952).

(9) Kaswell, E R, *Texile Fibers, Yarns, and Fabrics*, p 388, New York: Reinhold Publishing Corporation (1953).

DISCUSSION

Question: How long was a fabric exposed to the iron in your ironing experiments?

Answer: Ten seconds.

Q: How did you determine ironing temperatures?

A: Temperatures were all determined with a thermocouple.

Q: How much of a fiber must be present in a blended fabric to get a proper "Inner Structure"; would 10 or 15% show?

A: We have prepared many "Inner Structures" with 10% of Dynel, and some discrete Dynel "Inner Structures" have been obtained from fabrics containing only 5% of Dynel.

• CORRECTION

Your attention is called to errors in the nomenclature of Figures 7 and 8 of the article 'Carpet Soiling' on page P146 of the March 1, 1954 issue. The term . . . 'Regular Wool' . . . in each case should have read . . . 'Regular Rayon'. . . .

1953 Annual Convention——Cotton Session——

BETTER MERCERIZING FOR IMPROVED LUSTER*

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Harris Research Laboratories, Washington, D C

A review has been presented of those factors that affect the luster of cotton. Other than the mercerizing treatment, which is the principal means of improvement, the principal factors are the variety of cotton chosen (among which the long-staple American-Egyptian cottons are the most desirable), and singeing, which can exert an effect approximately half as great as that of mercerization. Additional small factors that contribute are the twist of the yarn, ply and yarn number. In fabrics, the weave pattern with the longest floats produces the highest luster. The sheerest fabrics are also most lustrous to the eye and in instrumental measurements.

The development of relatively simple tools for measuring luster permit the "tuning up" of the mercerization process in an individual mill. With these tools, it should be possible for the individual finisher to make objective determinations in his own process of the optimal conditions of concentration, length or stretch during mercerizing, repeated stretching and slacking, presence of wetting agents, and sequence of treatments. In particular, it appears that the use of a wetting agent produces a benefical effect even under the longer-time treatments used in the laboratory. Mercerization after kiering produces a higher level of luster than does kiering after mercerization.

In the study of the factors involved in mercerization with improved luster as the main objective, reliance on absorption or accessibility tests, such as the Barium Number, can be misleading. The guidance of physical measurements of optical properties, however, can usually lead to noticeable improvement in luster.

INTRODUCTION

IT has now been more than a century since John Mercer discovered that the treatment of cotton with strong solutions of sodium hydroxide improved its dyeing properties, and over 60 years since Lowe discovered that mercerization under tension improved its luster. In view of the long history of mercerization, and the great deal of competent attention which this subject has received, it seems somewhat surprising that there should be anything new to add to the subject at this late date. However, with the development in recent years of new tools for measuring the luster of yarns and fabrics quantitatively, it seems appropriate at this time to reassess the factors which govern the luster of cotton.

As is well known, the mercerizing process can be used to improve the dyeing properties of cotton, its mechanical properties, and its luster *(8)*. It is likewise well known that there is a certain incompatibility between the maximum improvement in dye uptake or elongation properties on the one hand, and the highest possible improvement in luster on the other; a compromise is usually made between these several properties. Thus, the use of maximum tension in mercerizing produces the greatest improvement in luster and strength, but the dyeing properties and extensibility are not enhanced to the degree possible when the fiber is treated in a more relaxed condition *(2)*. In the present paper, mercerizing will be considered primarily as a means of improving the luster of cotton, rather than the other properties. The use of mercerization in this connection is for the improvement of the appearance of the fiber in order to enhance its competitive position in the market place. In large measure, a high degree of luster is associated with high quality in the minds of people who manufacture, handle and purchase cotton, and this historical association no doubt contributes substantially to the use of the mercerization process. The situation thus provides one of the paradoxes which are so common in the textile industry, namely, an attempt is being made to enhance the luster of cotton so that it approaches that of the bright synthetic fibers, while some manufacturers of synthetic fibers concentrate their efforts on the reduction of the luster of their product.

A M Sookne

Preliminary to a discussion of the use of mercerization for improving the luster of cotton, it will be helpful to say a few words about the meaning of luster and the methods of measuring it. A further purpose of this paper is to describe the principal factors that enter into the manufacture of lustrous cotton goods, since there are numerous other factors besides the conditions of mercerization which affect this property in cotton. Finally, the effects on luster of some of the conditions of mercerization will be examined.

DEFINITION OF LUSTER AND MEANS OF MEASUREMENT

There are numerous definitions of the term luster *(2, 5)*, and it is not the purpose of this discussion to become involved in the problem of definition of terms in this complicated subject. Rather, an operational definition of luster will be used, which should amply fulfill our needs for the moment. Figures 1A and 1B show two extreme types of reflecting surfaces. The mirror reflects substantially all of the incident light with the angle of reflection being equal to the angle of incidence; in contrast, the rough surface, which is called a mat diffuser, scatters the incident light in a random fashion so that the reflection is equally intense no matter at what angle it is viewed. (A surface can be prepared by depositing magnesium oxide smoke on a flat surface, which actually fulfills this requirement to a high degree). If light is allowed to impinge on a surface at an angle of 45°, and if the surface is then observed at right angles to it as shown in Figure 1C, the light so reflected is a good measure of the diffusely reflected, or scattered light. The more lustrous a surface is, the greater the proportion of light which will be reflected in the manner shown in Figure 1A, while the rougher or less lustrous is the surface, the greater is the proportion which will be reflected as shown in Figure 1C. Thus, the ratio of these two quantities, the mirror-like reflection and the diffuse reflection, which has been termed the Contrast Ratio *(4)*, may be taken as one measure of luster. This quantity is defined by the relationship:

* A report of work done under contract with the U S Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract was supervised by the Southern Regional Research Laboratory of the Bureau of Agricultural and Engineering Chemistry. Presented by A M Sookne in the South Ballroom of the Conrad Hilton Hotel in Chicago on Friday afternoon, Sept 18, 1953, before the Cotton Session with H T Latham presiding. Submitted to the Reporter by the Editor of Prooceedings March 23, 1954.

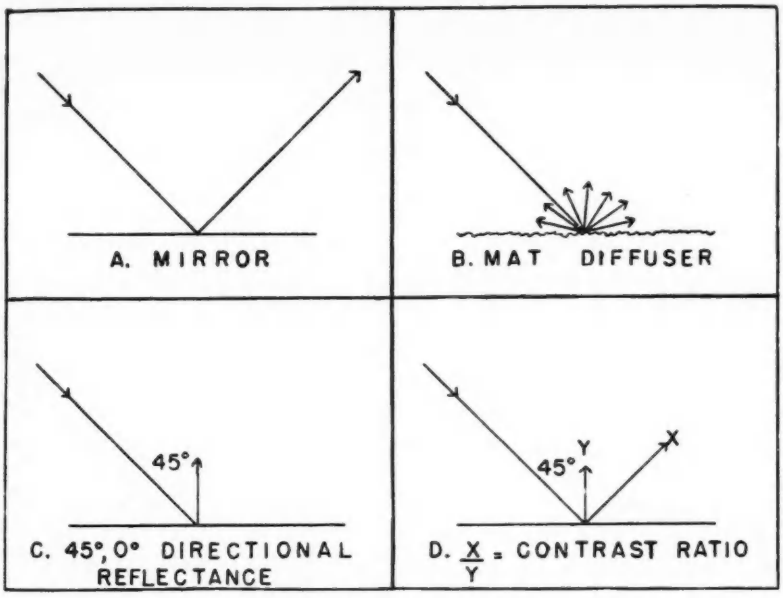

Figure 1

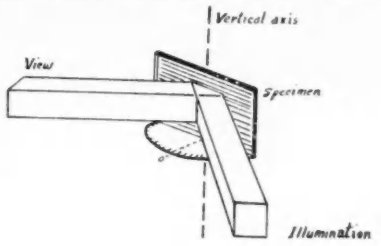

Figure 2

TABLE I

COMPARISON OF RANGES OF LUSTER OF COTTON AND RAYON

Material	*Contrast Ratio*
Ideal mirror	Infinity
Filament rayon, bright	100
Filament rayon, semi-dull	5
Filament rayon, dull	2.0
Mercerized cotton	2.3-2.8
Spun rayon, bright	2.2
Spun rayon, dull	1.4
Natural cotton	1.5-1.8
Ideal mat diffuser	1

$$\text{Contrast Ratio} = \frac{\text{Mirror-Like Reflectance}}{\text{Diffuse Reflectance}} = \frac{45°, 45° \text{ Directional Reflectance}}{45°, 0° \text{ Directional Reflectance}}$$

Throughout the present discussion, the Contrast Ratio will be taken as a measure of the luster of cotton yarns or fabrics, and this term will be used interchangeably with the term luster.

A diagram of the actual arrangement used in measuring the Contrast Ratio, or luster, of a sample of yarns or fabrics is given in Figure 2. In this diagram the yarns are arranged in a direction which is parallel to the plane containing the beams of incident and reflected light, and this was the position used in all of the experiments described below. As shown, the 45°, 45° apparent reflectance is being measured; a corresponding measure of the 45°, 0° apparent reflectance can be made in a separate measurement, or alternatively the two measurements can be combined in an instrument such as the Hunter Multipurpose Reflectometer *(7)*.

To provide some insight into the meaning of the term Contrast Ratio and its range in real materials, Table I compares this quantity for a number of different surfaces. The complete range of contrast ratio is from infinity for an ideal mirror (which can of course never be attained in practice) to unity for an ideal mat diffuser (which can very nearly be attained with a magnesium oxide coated surface). Table I shows the tremendous reduction in luster which is obtained through the use of titanium dioxide in filament rayon, as well as the correspondingly large reduction which is obtained by cutting the filament rayon into staple and spinning a yarn from it. These data indicate the rather surprising fact that mercerized cotton yarns are sometimes more lustrous than spun yarns made from bright rayon. The order of magnitude of improvement in luster which is obtained as a result of mercerization is likewise shown, and it is interesting to note that this is approximately the same as the difference between dull and bright spun rayon. As a further indication of the significance of Contrast-Ratio measurements, it should be noted that the instrument used can measure the Contrast Ratio of windings of yarn or samples of fabrics to approximately 0.02 unit. On repeated judgments, especially by a group of observers, the human eye can readily detect differences in contrast ratio of the order of 0.05 unit; differences very much smaller than this can easily be detected if samples of yarn are wound next to each other on a card, or are woven or knitted into a fabric of suitable structure.

It is perhaps also appropriate to distinguish at this point between the deep-seated luster obtained by mercerizing yarns, for example, and the surface luster obtained by a calendering treatment. Thus, while a surface smoothness which is obtained by heavy calendering gives a high contrast ratio as measured by a reflectometer, it does not produce as desirable an appearance to the human eye as does a mercerized fabric. This is principably because the eye is capable of detecting the highlights present in the individual yarns as they criss-cross in the fabric, while the machine is capable only of obtaining an average result for the sample with which it is faced. There are, however, machines which are capable of reproducing the reaction of the eye to a higher degree; such a machine has been described by Hume, Olson and Reese *(6)*. The results described below have to do for the most part with measurements of the luster of yarns prepared by winding them on cards as shown in Figure 2, for which this issue does not arise.

FACTORS AFFECTING LUSTER OF COTTON

Mercerizing is the most widely practiced means of improving the luster of cotton and can be one of the most effective. However, there are a number of additional factors which exert a considerable influence on the luster of the finished product. Among these are the variety of cotton used, the presence or absence of singeing, the twist, ply and fineness of the yarns, and in woven goods, the pattern of weaving and the sheerness or thickness of the fabric. The strong influence of variety is shown in Figure 3, which plots the contrast ratios of a number of different varieties chosen from the 1949 annual varietal and environmental study of the Bureau of Plant Industry *(1)*. All of these measurements were performed on unmercerized 36's, carded yarns. The graph shows both the range in luster as measured by the variety averages (plotted along the horizontal axis) and the variation in luster in individuals within each variety (plotted along the vertical axis). As shown by these results, even the unmercerized yarns exhibit a

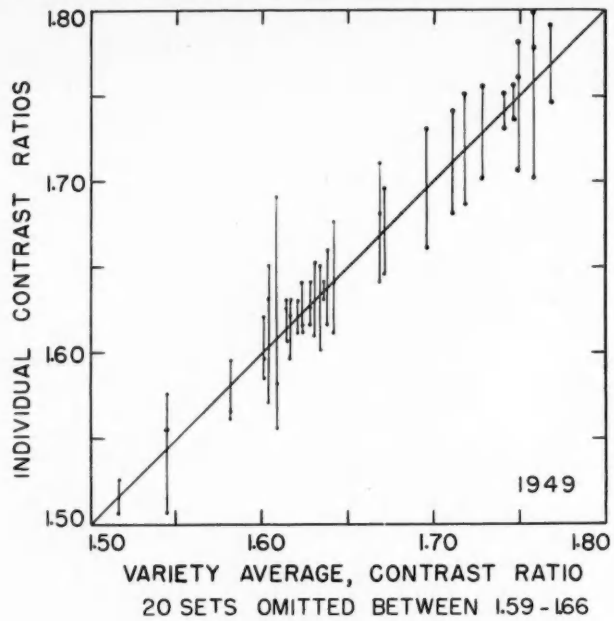

Figure 3

range in luster (as measured by contrast ratio) of approximately 1.5 to 1.8. A substantial, although smaller, variation in luster is likewise exhibited within varieties.

The effect of mercerizing on the range exhibited by different varieties of American cottons is shown in Figure 4. In these experiments, a group of singles cotton yarns from the 1949 crop were selected to cover the entire range of contrast ratios, with several representatives at each level of luster. These yarns were then mercerized at 101% of their original length; the length after neutralizing, rinsing and drying averaged close to the original length for the group as a whole. In Figure 4, the contrast ratios for the mercerized yarns are plotted against those for the grey yarns, and the results show that the contrast ratio increased more with mercerization the higher it was in the original grey yarn. The yarns in Figure 4 represent a wide range of varieties, but there is also a range of response to mercerizing within each variety. A comparison of this type, which presents the difference in Contrast Ratios after and before mercerization for an American-Egyption cotton (Pima) and two Upland American cottons is given in Figure 5. These results show the greater improvement in luster obtained with the Pima, as compared with the Deltapine and Rowden cottons. In general, similar results on various American cottons indicate that the American-Egyptian cottons as a class are more lustrous than even the better American Upland varieties, and respond better to mercerization. Examination of all the available physical measurements on these cottons indicates that the two properties most closely correlated with the luster before mercerization are length and strength, so that for mercerization or the development of high luster as well as many other desirable characteristics in cotton, these two factors are pre-eminent.

A second factor which exerts a very substantial effect on the luster of mercerized yarn is singeing, or gassing. The effects of both mercerizing and gassing on the luster of a group of commercial yarns is shown in Table II. These were all combed Peeler yarns with mercerizing twist, and represent three yarn numbers. As shown by these data, the effect of gassing was to increase the Contrast Ratio by 0.5 units, more than half of the increase which was achieved by mercerization itself. This very substantial improvement in luster as a result of gassing must be attributed to the singeing off of the small fuzzy hairs which otherwise would act as scattering centers to increase the amount of diffusely reflected light. This is of course a well known phenomenon, but the actual order of magnitude of the increase as shown by these measurements is surprisingly large.

Additional factors which play substantially smaller roles in the determination of the Contrast Ratio are the twist, ply and yarn number. It is beyond the scope of this paper to enter in detail into the effects of these factors, but it may be mentioned in passing that the Contrast Ratio in natural, that is, unmercerized, yarns is reduced approximately 0.06 units per unit increase in twist multiplier, the effect of plying is to improve the Contrast Ratio roughly 0.2 units, and the entire range in Contrast Ratio between cotton yarns of the same twist multiplier ranging from 10's through 60's is only 0.1. Thus, in unmercerized yarns these three factors can be considered as relatively minor in their effects on luster as compared with the effects of variety and gassing, for example. However, their effects may be larger for mercerized samples.

A final factor which affects the luster and should be considered at this point is that of fabric structure. It seems obvious that the most lustrous array of a group of fibers would be the most orderly one, in which all of the fibers are arranged neatly parallel to each other and in the same plane. A winding of low-twist yarns does approach this ideal arrangement to a degree. It is apparent that the introduction of a filling yarn at right angles to the warp produces a serious disarrangement and causes a great deal of light scattering, and so reduces the luster of the array. This is particularly true because of the fact that the weave pattern involves bending of the yarns at each intersection of warp and filling, and so further increases the scattered light, as contrasted with the light reflected in a mirror-like way. Thus, the weave which involves the smallest number of disturbances of this type, ie, has the longest floats, should be expected to result in the highest luster. A few measurements which confirm this relationship are presented in Table III. All of these numbers are obtained from fabrics woven from the same bleached cotton yarn, without, however, the benefits of mercerization. The data indicate a modest improvement in luster as the float is increased, and

TABLE II

EFFECT OF MERCERIZING AND GASSING ON THE LUSTER OF COMMERCIAL COMBED PEELER YARNS WITH MERCERIZING TWIST

		Contrast Ratio		
Yarn No.	*Cotton*	*Natural*	*Mercerized*	*Mercerized, Gassed*
20/2	Carolina	1.64	2.46	2.92
40/2	Delta and Western	1.64	2.52	2.93
50/2	Western, Acala	1.63	2.34	2.98
	Average	1.64	2.44	2.94
	Difference	0.80		0.50

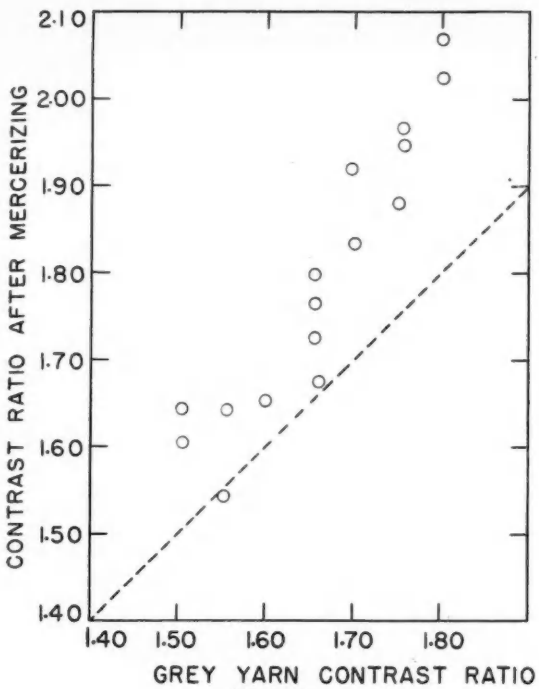

Figure 4

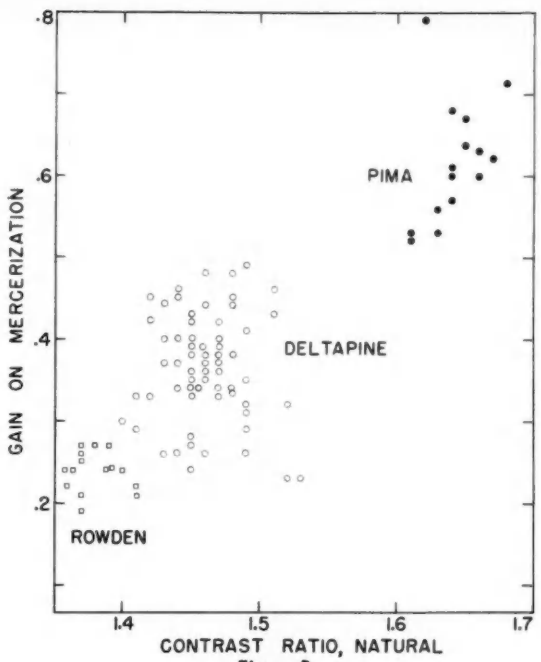

Figure 5

indeed these fabrics can be readily distinguished by eye in their degrees of luster. When the instrumental measurements are made parallel to the filling direction, however, little difference in luster is observed, since the instrument is capable of examining the two yarn sheets more or less independently.

A final effect of fabric structure that may be worth mentioning is the effect of sheerness or thickness of the fabric. Measurements made both on windings of yarn, fabrics of different weight and weave density, and successive layers of fabrics indicate that the sheerer the fabric, (or the greater the transparency) the higher the luster. This is because an increase in thickness provides enhanced opportunities for scattering of light from the depths of the fabric, and, as shown by the relationship which defines Contrast Ratio (see above), an increase in the denominator of the fraction will produce a reduction in Contrast Ratio, or luster. This effect, that the sheerer fabrics are the most lustrous, is apparent not only in the instrumental measurements but also to observation by the human eye.

EFFECTS OF MERCERIZING CONDITIONS ON THE LUSTER OF COTTON

The principal factor in improving the luster of cotton is of course mercerizing itself. The development of simple tools for measuring the luster as the Contrast Ratio now permits a re-examination of the conditions of mercerizing with the view in mind of obtaining optimum results by the presently employed procedures. For example, Table IV shows that there are small but significant differences in the Contrast Ratio of yarns mercerized at 23°C (73°F) with sodium hydroxide solutions varying from 20 to 25% concentration, and that the optimal results are obtained at approximately 23% concentration. This was true both of yarns mercerized at 100% of their original length (ie, held stretched at their original length) and for yarns which were stretched 2% beyond their original lengths during the mercerizing process. A comparison of the columns representing these two conditions of stretch indicates that the increased stretch produces appreciably higher luster. A more complete examination of this factor of stretch during mercerization is presented in Table V. These results represent a series of experiments in which the stretching of the yarn was varied both as it entered and as it was removed from the mercerizing bath, and the samples so obtained were characterized by measurements of both the Contrast Ratio and the Barium Number (3). The latter is a measure of the absorption of barium hydroxide by the sample of cotton, and is therefore an index of the accessibility of the cotton to the entrance of this reagent. The results in Table V indicate that the slacker the yarn when it is entered into the mercerizing solution, the higher the Barium Number, presumably because of improved penetration of the reagent into the yarns and fibers. In addition, the higher the stretch when the yarns were

TABLE III
EFFECT OF WEAVE ON THE LUSTER OF BLEACHED COTTON FABRICS[a]

Fabric	Warp Floats over	Contrast Ratio: Parallel to Warp	Contrast Ratio: Parallel to Filling
Broadcloth	1	1.44	1.33
Oxford[b]	1	1.40	1.34
Twill, 3/1	3	1.55	1.32
Sateen[c]	4	1.62	1.40

[a] All fabrics were woven 128 x 68, 40's warp, 42's filling. Measurements were made on the warp float face.
[b] Two ends over one pick.
[c] Five-harness warp.

TABLE IV
EFFECT OF CAUSTIC CONCENTRATION AND LENGTH DURING MERCERIZING ON YARN LUSTER[a]

NaOH Concentration	Contrast Ratio of Yarns Mercerized at 100% of Orig Length	Contrast Ratio of Yarns Mercerized at 102% of Orig Length
%		
20	1.64	1.70
21	1.65	1.68
22	1.69	1.74
23	1.72	1.79
24	1.74	1.76
25	1.69	1.72

[a] Yarn is 28's singles, 4.0-twist multiplier.

TABLE V

EFFECT OF LENGTH DURING MERCERIZING ON LUSTER AND BARIUM NUMBER OF COTTON YARNS[a]

Length During Mercerizing		*Finished Length*	*Contrast Ratio*	*Barium Number*
Initial	*Final*			
%	%	%		
Slack	104	101	2.65	155
96	104	101	2.54	150
100	104	101	2.56	144
103	104	101	2.45	140
Slack	100	98	2.36	156
96	100	97	2.19	143
100	100	97	2.23	141
103	100	97	2.33	151
Slack	96	94	2.09	158
96	96	94	2.08	155
100	96	93	2.06	154
104	96	93	2.06	156
Slack	Slack	78	1.55	169

[a] Acala 4-42 cotton, 36/2, commercial spinning, mercerizing twist.

TABLE VI

EFFECT OF ORDER OF PROCESSING ON LUSTER AND BARIUM NUMBER

Sample	*Contrast Ratio*	*Barium Number*
Grey yarn	1.78	100
Kiered only	1.71	103
Mercerized only	2.37	141
Kiered, then mercerized	2.54	138
Mercerized, then kiered	2.32	129

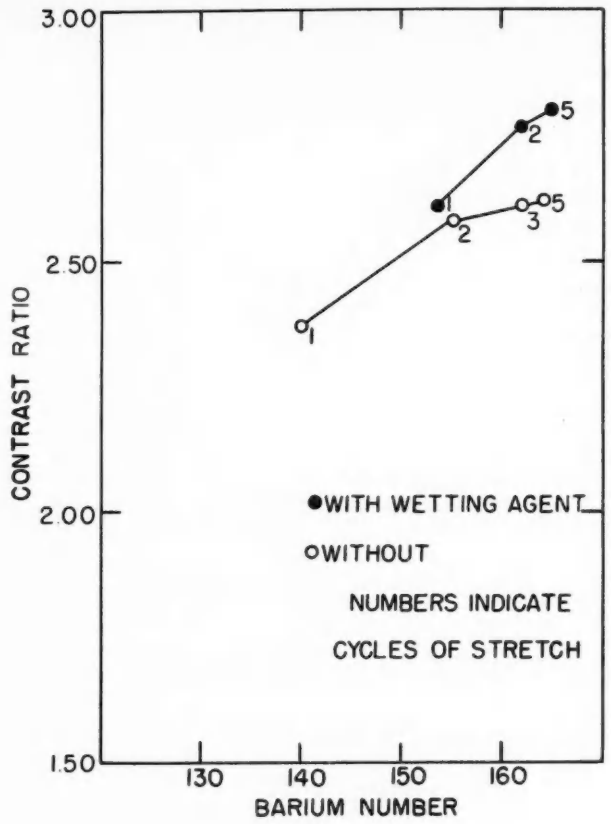

Figure 6

removed from the sodium hydroxide solution, the higher the Contrast Ratio, but this factor was without effect on the Barium Number. Thus, while the Barium Number paralleled the Contrast Ratio and luster for any one series of experiments (for example all of those in which the yarn was removed at 100% stretch), it did not provide a reliable indication of luster for the series as a whole. The Contrast Ratio may therefore be a more direct and informative measure when it is intended to adjust the conditions of mercerization to obtain optimum luster; the Barium Number, on the other hand, may be more useful in treatments designed to improve dye absorption and color value.

An additional variation of technique which is sometimes used to improve the effect of mercerizing is to alternately stretch and slack yarns during the mercerizing process. The effects of such repeated stretchings and slackings both in the presence and absence of a wetting agent of the cresylic acid type, are shown in Figure 6. These data indicate that repeated stretching and slacking produces some improvement in the luster of the yarn not only in the absence of wetting agents, but even when the wetting agent is present. In view of the fact that the time in the caustic solution is substantially greater in these experiments than that used in commercial practice, this result indicates that the more widespread use of wetting agent in mercerization might be commercially desirable. The results also compare the luster as measured by the Contrast Ratio with the Barium Number of the treated samples, and show once again that there is not a one-to-one correspondence between these two measures.

A final factor in mercerizing which has been investigated and which shows an appreciable effect is that of the order of processing. Table VI compares the effect on luster of kiering before mercerizing, as compared with mercerizing before kiering. The data indicate that the kiering of a grey yarn actually reduces its luster to a small degree, and likewise that the kiering of a mercerized yarn produces a small but definite decrease in Contrast Ratio. The improvement in Contrast Ratio obtainable by kiering before mercerizing is approximately 0.2 units, a rather substantial difference easily observed by the human eye. It must be noted in this connection that certain economic factors, such as the question of consumption of caustic, may militate against the use of the procedure which gives the higher degree of luster. It is necessary in this procedure for each mill to balance the improvement which is obtained against the increase in cost, and this is true of course for many of the factors which have been mentioned above as well.

CONCLUSION

Many of the factors which affect the luster of cotton are beyond the control of the yarn mercerizer or fabric finisher; these include the kind of cotton used and the yarn and fabric structure. However, there are additional factors within the mercerizer's control which can have an important effect on yarn or fabric luster. To obtain the highest level of luster, it is suggested that each finisher examine his own process with quantitative tools of the type described above, and "tune up" his conditions of treatment.

REFERENCES

(1) Anon. (Division of Cotton and other Fiber Crops, USDA). Annual varietal and environmental study of fiber and spinning properties of cottons. 1949 crop. Mimeo-

graphed, Plant Industry Station, Beltsville, Maryland (1950).
(2) Buck, G S, Jr, and McCord, F A, *Textile Research J* 19, 715 (1949).
(3) Edelstein, S M, *Am Dyestuff Reptr* 25, 186 (1936).
(4) Fourt, L, and Sookne, A M, *Textile Research J* 21, 469 (1951).
(5) Harrison, V G W, "Definition and Measurement of Gloss", London, The Printing and Allied Trades Research Association (1945).
(6) Hume, H F, Olson, E H, and Reese, C E, *Textile Research J* 23, 123 (1953).
(7) Hunter, R S, *J Research Nat'l Bur Standards* 25, 581 (1940).
(8) Marsh, J T, "Mercerizing", London, Chapman and Hall (1941).

DISCUSSION

Question: Why does mercerization improve the luster of cotton?

Answer: The consensus is that mercerizing improves luster because it changes the shape of cotton from a twisted ribbon to something more nearly like a cylindrical structure with a smoothed-out surface, as a result of the swelling action of the strong caustic soda. The smooth surface is more like a mirror and the luster increases. While internal factors may have an effect, most workers in this field hold to the explanation just given.

Q: Most mercerization evaluations, I think, are carried out on yarns. Do the same principles follow from mercerization of fabrics?

A: Fourt has found from much work on fabric mercerization that the same principles in general hold quite well. It is easier to see the results with yarns with the particular types of instruments readily available, because, in fabrics, filling yarns intersect the warp yarns, and the crisscrossing of the yarns tends to give a lower luster for fabrics than yarns. Although the measurements are therefore harder to make, the principles remain the same. Maximum effective concentrations and other factors would operate similarly for fabrics and the mercerizer could tune up his process by the same methods.

Q: How small a Contrast Ratio can be seen? Can you see 0.1 to 0.2 unit with the eye?

A: Actually, the instrument can measure two-hundredths of a Contrast-Ratio unit, and, if you have an ordinary person looking at two samples of yarn on cards, such as I showed you, and he holds them up like this, he can easily see 0.05 difference in Contrast Ratio. However, in windings of yarn which are right next to one another, so they touch, or in a knitted fabric you can see very much smaller differences. If you have a critical test with the yarns right next to one another you can see remarkably small differences because the eye is extremely sensitive.

Q: What instruments do you use for making these tests?

A: They were made on the Hunter Reflectometer and on the Hunter Gonio-Photometer, both manufactured by Gardner Laboratory and originally developed in the National Bureau of Standards.

Q: Do you care to comment on the luster of a viscose fiber, which should have a mat surface?

A: An ordinary viscose fiber actually looks like a kind of Greek column that has flutes in it, that is, crevices that run along the length of the fiber. If you take a column and shoot a beam of light in the direction in which the fibers are pointed, it is very shiny, and if you shoot it in at right angles to the yarns, then you have the effect of the pits or crevices in the surface of the fiber and it is indeed rougher in that direction; but taken as a whole a viscose fiber is very smooth compared with cotton.

Q: Is there any difference between the efficiency of caustic soda and caustic potash?

A: Caustic potash is less efficient and more expensive. It is sometimes used in mercerizing blends of cotton and rayon, however, because rayon is less sensitive to caustic potash.

Q: Have you made any quantitative study of the relationship between luster and twist?

A: Yes, this is one of the factors that Dr Fourt has studied, and this will be in one of his papers, which will come out shortly. Actually the number I recall is that you get a change in the order 0.05 to 0.1 in Contrast Ratio per change of twist multiplier; that is, if you go from a twist multiplier of two and a half to three and a half it will drop your luster from 0.05 to 0.1.

Q: Can you tell me what difference in the degree of luster you could get in mercerizing at different temperatures, say, the maximum down to the lowest?

A: This is a subject that we have not gone into but which J T Marsh has reported upon in his book on mercerizing. He says, the lower the temperature, the larger the effect for a given concentration of caustic soda. Refrigeration of the bath therefore permits use of lower concentrations. The maximum luster, however, will not be increased; that is, you can get as much luster at room temperature as at lower temperatures. For cost reasons it is therefore usual to mercerize without refrigeration.

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THE BEHAVIOR OF OPTICAL BLEACHING AGENTS ON CELLULOSIC MATERIALS*

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INTRODUCTION

THE whitening of cellulosic fibers by fluorescent compounds was first reported almost 25 years ago. Since that time, there has been a considerable amount of research on the preparation of these compounds, the measurement of their chemical and physical properties, and the development of new uses and methods of application. These efforts have been crowned with commercial success, so that today these compounds find extensive use in the textile and allied industries.

THEORY OF OPTICAL BLEACHING ——The mechanism by which these fluorescent compounds, or so-called optical bleaching agents, whiten cellulose is fairly well understood. In contrast to the conventional bleaching agents, which produce a whitening effect by chemical degradation of the colored impurities in the cellulose, the optical bleaching agents do not chemically affect these impurities but merely compensate optically for their deleterious effects.

Since the impurities in cellulose generally absorb the bluish light of the visible spectrum to make the fiber appear objectionably yellow, the addition of blue light from another source will neutralize this yellowness and give a whitening effect. When properly applied to the cellulose, the optical bleaching agents absorb the invisible, near-ultraviolet radiation (300-400 mμ) present in natural daylight and, to a lesser extent, in ordinary artificial light, and emit this energy at longer wave lengths, which are in the blue region (400-500 mμ) of the visible spectrum. This phenomenon, known as fluorescence, provides the blue light required to compensate for the yellowness caused by the impurities in the cellulose. Unlike ordinary bluing agents, which absorb part of the incident visual light, the optical bleaching agents increase the amount of visible light coming from the surface and therefore impart added brightness as well as whiteness.

S N Glarum

Although the physical and chemical properties of optical bleaches and their applications have been frequently presented in the literature, there seems to have been little utilization or recognition of the fundamental concepts underlying the behavior of optical bleaches on a fibrous, cellulosic substrate.

From theoretical concepts and empirical observations of fluorescent compounds in various systems it is apparent that there should be a fundamental relationship between the concentration of an optical bleach on a textile substrate and the intensity of the visible light which is emitted when the system is subjected to a suitable ultraviolet source.

Consideration of the experimental data obtained from applications of optical bleaches on cellulose indicates that the fluorescence - concentration relationships found to exist are consistent with certain theoretically derived mathematical expressions and analogous to other fluorescent compound-solvent systems. In addition, the adsorption isotherms resulting from the fluorescence-concentration data are also consistent with certain well established theoretical and empirical observations.

This fundamental aspect of the behavior of optical bleaches on cellulose is of practical importance for investigating the kinetics of exhaust applications, determining dyebath exhaustion values, and estimating visual whiteness on the basis of fluorescence measurements.

In view of the fluorescent action of the compounds and their brightening as well as whitening effect, optical bleaching agents are also known as fluorescent bleaching agents and as brighteners.

PROPERTIES OF OPTICAL BLEACHING AGENTS——Many of the optical bleaching agents used on cellulose are chemically analogous to direct dyestuffs. The most important classes are derivatives of diaminostilbene or benzimidazole. The nature and the position of the substituent groups vary considerably and determine the important chemical and physical properties of these compounds.

A satisfactory optical bleaching agent should be highly efficient in converting the ultraviolet radiation to visible light in the blue region of the spectrum and should not absorb any visible light to cause a discoloring effect on the substrate. It must have sufficient solubility or dispersibility to permit easy application, and a certain amount of substantivity is also required for many applications. It is also desirable that the optical bleaching agents be suitably stable towards various chemicals and conditions encountered in application and during the end use of the products on which they are applied. In addition, it should have no harmful physiological effects.

PRACTICAL APPLICATION OF OPTICAL BLEACHING AGENTS——From the numerous optical bleaching agents that are available today, products can be selected which are applicable to cellulose under a wide variety of conditions. In the textile industry, for example, they are extensively used for the whitening of yarns, fabrics, and knitted goods. They may be used either to minimize the degree of chemical bleaching required or to obtain a whiteness superior to that obtainable by chemical bleaching or bluing. The available optical bleaches may be applied by exhaustion or padding, either as a separate treatment during wet processing, or in combination treatments during chemical bleaching, washing, rinsing, discharge printing, pastel dyeing, or application of finishing agents. In some cases they may be put into synthetic fibers during manufacture.

* Presented by S N Glarum in the South Ballroom of the Conrad Hilton Hotel in Chicago, Ill, on Friday, Sept 18, 1953, before the Cotton Session with H T Latham presiding. Submitted to the Reporter by the Editor of Proceedings on March 25, 1954.

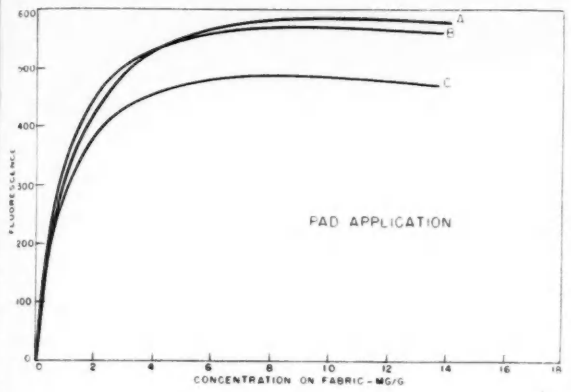


Figure 1

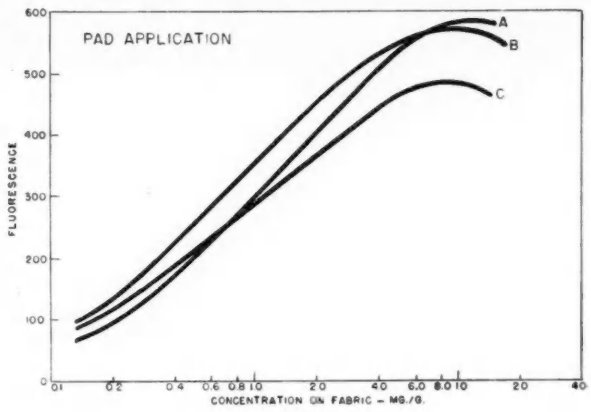


Figure 2

Optical bleaches are also used extensively in combination with detergents and souring agents for the whitening of cellulosic articles during home and commercial laundering.

Another large use of optical bleaching agents on cellulose is in the whitening of paper. They may be applied to the pulp in the beater, padded on the finished paper, or combined with coating compositions.

CONCENTRATION-FLUORESCENCE RELATIONSHIPS

Although the mechanism of optical bleaching, the preparation of suitable fluorescent compounds, and the methods of application have been widely investigated, there appears to be little information concerning the more fundamental aspects of the behavior of these products on cellulosic substrates. One of the most important basic factors is the relationship between the concentration of optical bleaching agent on the cellulose and the fluorescence intensity of the system. It should be emphasized that it is not the fluorescence intensity of the optical bleaching agents alone that is being considered, but it is the fluorescence of the system consisting of the optical bleach and a cellulosic substrate.

In the pure state, most of the optical bleaching agents are dull-colored solids with no visible indication of the effects that can be obtained when they are properly applied to a suitable substrate. It has been found that the manner of application, the concentration, and the nature of the substrate may each influence the behavior of a fluorescent compound. The work considered here has been confined to a cellulosic substrate and to water-soluble, commercially available optical bleaches designed for application to cellulose.

The relationship between the concentration of each optical bleaching agent on cellulose and the fluorescence intensity of the system was determined by padding solutions of different concentrations on samples of bleached, mercerized, cotton percale. The concentration of optical bleach on the fabric after padding and drying was calculated from the solution concentration and the wet pickup. The fluorescence intensity of each treated sample was determined by irradiating it with ultraviolet rays and measuring the intensity of visible light emitted. Suitable filters were used to remove visible light from the incident ultraviolet radiation and to remove ultraviolet from the emitted visible light.

Figure 1 shows the fluorescence intensity plotted on linear co-ordinates as a function of the concentration of optical bleach on the cellulose for three commercial products. These curves show that products A and B can produce greater fluorescence than product C, but in the range of low concentrations used in practice it is imposible to distinguish between the curves on this scale.

A much better graphical representation of these data may be obtained by plotting the fluorescence intensity against the logarithm of the concentration. Figure 2 shows the same data as shown in Figure 1 plotted in this way. This provides a much clearer picture of the relative effectiveness of the three compounds. In this case, it is apparent that there is a nearly linear relationship between the fluorescence intensity and the logarithm of the concentration over a substantial portion of the concentration range for each product. It is of interest to note also that the fluorescence reaches a maximum and then decreases as the concentration is increased further. This effect is also shown in Figure 1 but it is not so noticeable.

Figure 3 shows the wide variations that are found in the fluorescence-log concentration relationships of several other commercially available optical bleaching agents, all of which are recommended for application to cellulose. Since these are commercial products, no information is available as to their purity. The presence of a diluent would affect the displacement along the log-concentration axis, but if the diluent has been properly selected, it should not alter the slope of the linear portion of the curve or the maximum fluorescence value.

The greatly different maximum fluorescence values shown by the various products is of considerable practical importance. The product represented by curve G in Figure 3 produces relatively high fluorescence at very low concentrations but reaches a maximum much below several other products. It is apparent that, regardless of the initially high relative effectiveness at low concentrations, this product cannot produce as great a degree of fluorescence as obtainable with the product represented by curve D, for example, which has a much higher maximum.

The varying slopes of the curves show why it is sometimes difficult to make an accurate strength comparison of two products. For example, at low concentrations, the product represented by curve H will appear to be much stronger than that represented by curve D, while at high concentrations, the relative strengths will be reversed. In general, it may be considered that a product exhibiting a greater slope in the linear portion of the curve is potentially more efficient in converting ultraviolet radiation to visible light.

Another interesting aspect of the fluorescence-concentration relationships found in the optical bleach-cellulose system is their similarity to the relationships which have been found in other systems. DeMent *(1)* has summarized this general relationship for systems previously studied by stating that, "On increasing the active agent or fluorescent substance for either

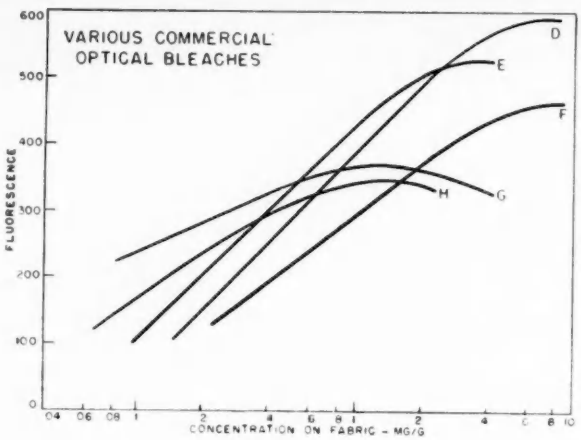


Figure 3

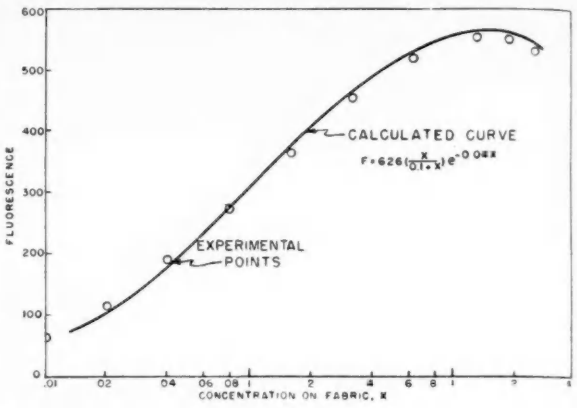


Figure 4

solids or liquids, the intensity of luminescence at first increases, reaching a maximum, and then shows a rapid decrease with further increases in concentration." This effect has been observed in the optical bleach-cellulose system as shown in Figures 1, 2 and 3. Various investigators have endeavored to develop a mathematical expression for the relationship between the concentration of fluorescent substances, in either liquid or solid solutions, and the fluorescence intensity of the system, and have offered theoretical explanations for the existence of the optimum concentration at which a system exhibits maximum fluorescence intensity. Although it is beyond the scope of this discussion to dwell in detail on the previous theoretical and experimental observations pertaining to this subject, it may be stated that to date there does not appear to be any definite agreement on either the cause of this observed critical concentration or the quantitative relationship between fluorescence intensity and concentration.

Examination of our data has indicated, however, that there is good correlation between the fluorescence-concentration data obtained for the optical bleach-cellulose system and a mathematical expression proposed by Merritt *(2)*:

$$F = A\left(\frac{x}{c+x}\right)e^{-kx}$$

F is the fluorescence intensity, *A* and *k* are constants, *x* is the concentration of active ingredient, *e* is the base of natural logarithms, and *c* is a constant depending upon the absorption of the solid solvent or substrate. This expression was derived by Merritt from theoretical considerations and found to be consistent with experimental data pertaining to the fluorescence of uranium salts in inorganic crystals.

Figure 4 shows the agreement between a calculated curve, based on Merritt's equation, and the experimental data resulting from measurement of the fluorescence-concentration relationship of a typical optical bleach-cellulose system. The values used for the constants were A = 626, k = 0.04 and c = 0.10. Although Merritt's expression is based on certain theoretical assumptions pertaining to the structure of the fluorescent system and the validity of these assumptions has been questioned by other investigators who have proposed slightly different equations to show the relationship between fluorescence intensity and concentration, it has been found that the Merritt equation fits the data obtained for the optical bleach-cellulose system in this study better than the other equations that have been proposed.

ADSORPTION ISOTHERMS

The previous data have been obtained by direct application of the optical bleaching agents to the cellulose by padding. Although some fluorescent compounds show little or no effect when applied by this method but, nevertheless, show excellent effects when applied by exhaust methods (and with other compounds the reverse is true), most of the commercial products have been selected to permit application by either method. It was of interest, therefore, to investigate the behavior of optical bleaching agents when applied to cellulose by exhaustion methods.

The same commercial optical bleaching agents that were used previously were applied to bleached, mercerized cotton percale from 30:1 baths containing 5 grams per liter of sodium sulphate and varying concentrations of the optical bleach. Applications were carried out in the Launder-Ometer for 30 minutes at 25°C, (77°F). The treated samples were rinsed for 15 seconds in cold, running, tap water, hydroextracted and air-dried away from direct sunlight.

The fluorescence intensities of the treated samples were measured by the same method used for the padded fabrics and the results are shown in Figure 5. The fluorescence-concentration curves have the same characteristic shapes as found for the pad applications. The intensity of the fluorescence increases linearly with the logarithm of the concentration over a substantial portion of the concentration range. At higher concentrations the fluorescence reaches a maximum and then decreases as found previously. The curves obtained by exhaust application are somewhat flatter than those obtained by pad application but this would be expected since all of the optical bleaching agent is not exhausted from the bath.

These data indicate that there is little difference in the fluorescence-concentration relationship for these selected compounds regardless of whether they are applied by exhaustion or padding. If this is the case, then the amounts of optical bleaching agent deposited on the cellulose by exhaust application can be determined from the fluorescence-intensity measurements by comparing the values with the padding data where known amounts of the compounds were applied to the cellulose. Since the amounts originally in the baths are known, it is possible to express the equilibrium conditions in the form of adsorption isotherms showing how the concentration of optical bleach on the fiber varies with the equilibrium concentration in the bath and to compare the behavior of the optical bleaching agents with that of dyestuffs in similar applications.

Investigation of the dyeing equilibria for many substantive-type dyestuffs has shown that the relationship between the concentration of the dye on the fiber, [D]f, and the concentration of dye in solution, [D]s, may be expressed by the empirically derived Freundlich equation:

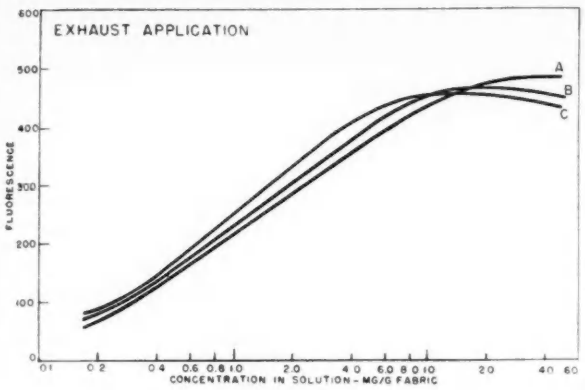


Figure 5

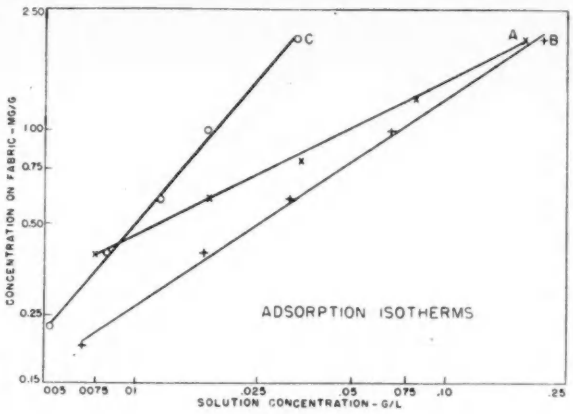


Figure 6

$$\{D\}_f = k\,\{D\}_s^x$$

where k is a constant and x is a fractional power. The characteristics of this equation are such that if the logarithms of the concentrations in each phase are plotted, a straight line should be obtained with slope x.

In the case of the optical bleaches studied, a plot of the log-concentration of optical bleach on the fiber against the log-concentration of optical bleach in solution gave straight lines as shown in Figure 6. These straight-line adsorption isotherms not only show that optical bleaching agents behave similar to substantive dyestuffs but confirm the validity of the assumption that under certain conditions fluorescence intensity values can serve as a reliable measure of the optical-bleach concentration on the cellulosic substrate.

Although it is not possible to dwell on all aspects of the practical significance of these adsorption isotherms at this time, it should be pointed out that they may be used to great advantage for studying the effects of different variables during exhaust application of optical bleaches. This is true, of course, only insofar as these variables affect the degree of exhaustion of the optical bleaching agents and will not apply if the optical bleaches suffer any chemical or physical degradation during or after application.

FLUORESCENCE-VISUAL WHITENESS RELATIONSHIPS

So far, it has been shown that there are several interesting aspects of the relationship between concentration of optical bleaching agent on a cellulosic substrate and the fluorescence intensity of the resulting system. On a practical basis, however, it is the relationship of the concentration and fluorescence to the visual whiteness that is of major interest.

As pointed out previously, the visible light emitted by optical bleaching agents is usually in the blue region of the visible spectrum, which compensates for the absorption of blue light by impurities. When the visible light emitted is towards the violet end of this region, the optical bleach imparts a reddish cast to the cellulose. This cast tends to become bluer or greener as the predominant wave lengths of the emitted light increase, depending upon the physicochemical properties of the optical bleach in question. Since the intensity of this cast increases with the concentration, there is a point of diminishing return where the predominant color, or cast, becomes objectionable and the neutralizing effect and increased brightness caused by the optical bleach cease to impart improved visual whiteness. In some cases, there is also a possibility that, when the concentration of optical bleach on the substrate becomes too high, discoloration may result because of the selective absorption of part of the incident visible light by either the optical bleach or attendant impurities.

In the practical application of optical bleaches it is the visual whitening effect which is important but this is not easily measured directly. The fluorescence intensity is more easily measured. Visual whiteness, however, even among these specially selected products is not always directly proportional to the fluorescence intensity. Aside from the loss of visual whiteness due to discoloration by intensive cast and the color of either the optical bleach or impurities in the product as just pointed out, only that part of the total fluorescent light which neutralizes the objectionable yellowish color of off-white materials will have a beneficial effect on the visual whiteness. In measuring fluorescence intensity, however, all of the emitted light is measured independent of its color.

In order to determine the correlation, if any, between fluorescence and visual whiteness, the samples exhibiting the concentration-fluorescence relationships shown in Figure 3 were visually evaluated for relative degree of whiteness. Within the linear portions of the curves there was excellent correlation between the relative fluorescence intensity of any two samples having similar casts and the relative degree of visual whiteness. Visual comparisons for degree of whiteness can only be satisfactorily made, however, when the casts of the two products are similar. When one sample possesses a greenish cast and another a reddish cast, even though the fluorescence intensities of both samples may be the same, ratings of visual whiteness will depend upon the personal preference of the observer.

It was extremely interesting to find that, at the higher concentrations where the slope of the fluorescence—log-concentration curves began to deviate from linearity, the samples began to show objectionable discoloration.

The fluorescence-visual whiteness relationship developed suggests that the linear portion of the fluorescence—log-concentration curve indicates the practical range of concentrations at which a particular product may be applied. Concentrations below this range will give insignificant whitening effects and higher concentrations will probably produce objectionable discoloration. Thus the concentration-fluorescence relationships are of very great practical importance.

SUMMARY

In this rather brief discussion, an attempt has been made to illustrate some of the more fundamental aspects of the behavior of optical bleaching agents on cellulose. In particular, the nature of the relationship between the concentration of optical bleach on cellulose and the fluorescence intensity of the system has been described. This relationship has been found to be consistent with certain empirical and theoretical laws of fluores-

cence, and is useful for investigating the relative strengths, purities, and efficiencies of comparable, optically active products. Secondly, the adsorption isotherms resulting from measurements of the equilibria prevailing after exhaust application of optical bleaches have been shown to be similar to those obtained in the case of substantive dyestuffs, and the usefulness of adsorption isotherms for studying the practical applications of optical bleaches has been indicated. Finally, certain relationships between fluorescence intensity and visual whiteness have been considered, and the value and limitations of fluorescence measurements as a measure of visual whiteness have been shown.

LITERATURE

(1) DeMent, Jack, *Fluorochemistry*, Chemical Publishing Company, Inc, p 90, New York (1945).
(2) Merritt, Ernest, *J Opt Soc Am* 12, 613 (1936).

DISCUSSION

Question: Will a lack of sunlight resistance be a factor in causing dissatisfaction with optical bleaches?

Answer: The question of the light fastness of most of these products is one that we would like to ignore. In general most of them have relatively poor fastness to exposure in a Fade-Ometer or to direct sunlight. However, there have been no difficulties in the storage of textiles treated with optical bleaches. Extensive tests have to be made on all compounds before they are offered to the trade. We have seen some which will produce objectionable yellowness if they are exposed to light, but I would say the products commercially offered have been tested and found satisfactory in that respect. None of them have what we would call good fastness to light.

Q: How is fluorescence determined?

A: The fluorescence is determined by an arrangement that I can sketch if you can see the board. We have an ultraviolet lamp here. The radiation is passed through a filter which filters out all the visible light, and then onto the specimen we are considering. The visible light coming off the surface of the specimen is diffused, as Mr Sookne has illustrated in the previous paper. This light is passed through a filter, which takes out any ultraviolet rays that might be reflected so only the visible light gets through this filter. The intensity of the visible light coming through is then measured by a photocell.

Q: Could you adapt the Hunter reflectometer to that?

A: I don't know whether the Hunter has an ultraviolet source or not. If it does I feel sure it could be adapted. There are a number of pieces of equipment on the market which can be used. Actually, we constructed our own setup with just a standard UV lamp from a laboratory supply house and a photometer. Filters are available from Corning. Coleman and others have instruments that can be used for such measurements.

Q: We have had trouble with the solubility of optical whiteners, especially in the presence of peroxide.

A: I would suggest the use of water-soluble types or dispersing agents. They should be predissolved or dispersed before addition.

Q: That is what we attempted to do, but we often ended up with about a tenth of what we had to start with.

A: There is no reason you couldn't use some wetting agent to help out in this trouble. I haven't previously heard any reports of such difficulties in application. If you are making a very concentrated solution, perhaps you would have trouble, but I would say that the stock solution you make should not be stronger than five or ten percent.

Q: Is there enough ultraviolet in an ordinary fluorescent lamp to cause any brightening with these optical bleaches?

A: Yes, even in an ordinary incandescent light, which surprised me when I first got into this.

Q: Has there been any study of the effect of the pH of solutions in application on the final fluorescence?

A: The pH of an application bath affects the exhaustion of an optical bleach. Other effects depend upon the specific product. Some of the products are discolored and turn yellowish if applied from an acid bath, probably because of a rearrangement within the compound. Making the treated goods neutral or slightly alkaline will remove this yellowness and restore the brightness. I would say the particular effect of pH would vary widely with the different compounds that are used.

REPORTS FROM THE LOCAL SECTIONS

Piedmont

THE Spring meeting of the Piedmont Section was held on April 10th at the Hotel Roanoke, Roanoke, Va, with approximately 200 members and guests attending. A meeting of the Section's Research Committee was held in the morning with Edward A Murray presiding.

At the afternoon technical session, Victor S Salvin, Celanese Corp of America presented a paper entitled "Improved Washfastness of Acetate-Rayon Blends". This was followed by the presentation of two student contest papers: "A Study of the Dyeing of Dacron Fabrics by Modification of the Carrier Method" by Zoddie L Collins of Clemson College, and "Factors Affecting the Fluorescence of Cotton" by George H Lourigan of the School of Textiles, North Carolina State College. The latter paper was declared the winner.

Warren E Foster served as guest speaker at the evening banquet.

Georgia Tech

THE Student Chapter at the Georgia Institute of Technology held business meetings on March 9 and April 5 to discuss bylaws, student award, the coming convention in Atlanta, qualifications for membership and programs. The following committees were appointed: *Project*—Carlson, Ranieri, Wilson; *Bylaws*—Webb, West; *Social*—Ranieri, Webb, Wilson; *Publicity*—Leftcoff, Ross.

Buttons bearing the insignia of the AATCC are now available from the Secretary at a new price of $2.25. Pins, with safety clasp, are also available at $2.50 each. Write directly to H C Chapin, AATCC Secretary, Lowell Technological Institute, Lowell, Mass.

Southeastern

THE spring meeting of the Southeastern Section, held at the Ralston Hotel, Columbus, Georgia, on March 27th, featured an open forum on "The Application of Vat and Direct Dyes". Approximately 200 attended the afternoon session and the dinner session following. Tracey Davis, Massachusetts Life Insurance Company, Columbus, Georgia was guest speaker.

The quiz program was in charge of R B Hallowell of Clark Thread Company, Albany, Georgia. The panel included Frank Cooper, Jr of A & M Karagheusian, Albany, Ga; James Stradley of E I du Pont de Nemours & Company, Inc, Atlanta, Ga; Robert H Harris, Spalding Knitting Mills, Griffin, Ga; Howard McCamy, Pepperell Mfg Co, Lindale, Ga; Robert H Nuttall, American Aniline Products, Inc, Charlotte, N C; and Boyce C Bond, Pittsburgh Coke & Chemical Company, Bala-Cynwyd, Pennsylvania.

HISTORICAL NOTES ON THE WET-PROCESSING INDUSTRY

IV—THE ROLE OF ROBERT HOOKE

SIDNEY M EDELSTEIN

This is the fourth in a series of historical articles which the textile chemist and colorist will find of interest.

The author, a prominent science historian, is the founder of an outstanding collection of great works, documents and letters in the history of chemistry and related sciences.

Articles and illustrations in this series are from the author's library.

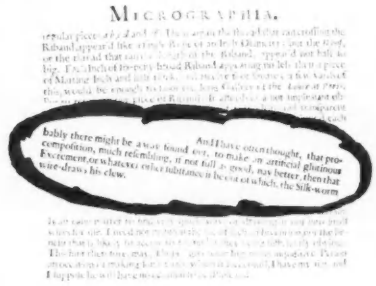
IN the preface to practically every treatise on synthetic fibers each author usually begins with the statement that the manufacture of synthetic fibers was predicted long ago by a man named Hooke, Hook or Huk. The dates for this prediction have been given as 1654, 1664, 1665, 1745 and 1780. Sometimes they report that this prediction was made before the Royal Society and sometimes, that it appeared in a book called "Micrographia."

The fact of the matter is that this first prediction of the manufacture of synthetic fibers was made by Robert Hooke on page 7 of his book entitled "Micrographia, or Some Physiological Descriptions of Minute Bodies made by Magnifying Glasses with Observations and Inquiries Thereupon." A photograph of this page from the book with Hooke's prediction indicated is shown in Figure 1. This book was published in London in 1665 by the order of the Royal Society of London for Improving of Natural Knowledge of which Hooke was curator and an outstanding member. Perhaps the confusion over the dates which have been given for Hooke's prediction is due to the fact that a second edition was published in 1667 and the plates from the books were also issued in 1745 and 1780.

Since few modern authors of articles on synthetic fibers have ever seen a copy of "Micrographia", one might be led to believe that this work was not important or even well-known in its own time. Quite the reverse is true. "Micrographia" was anxiously awaited by "society" of 17th century England and upon its publication it was bought and read as avidly as a novel by a best-selling author might be today. Even Pepys, the Walter Winchell of Hooke's time, wrote that, on the 20th of January, 1665, he went to his bookseller "and there took home Hooke's book on microscopy, a most excellent piece, and of which I am very proud." Even today "Micrographia", now extremely rare, is sought after by many collectors. The desire to own a copy is due not only to the book's great place in the history of science, but also because it contains many fine drawings from the hand of Robert Hooke showing his ability to note and record the most minute details. Finally the engraver's art itself in reproducing by hand is another highlight of this quarto.

The microscopical discourses in the book are for the most part results of experiments that Hooke had presented for several years before the Royal Society. These observations include the examinations of such diverse things as leeches in vinegar, a bluish mold on leather, the head of a fly, the edge of a razor and the structure of fine lawn and silk fabric from Virginia. (See Figures 2 and 3)

This microscopical work of Hooke laid the foundation for such modern microscopical sciences as histology, pathology and also textile microscopy. His improved compound microscope, which he designed and built himself and which is described in "Micrographia", was the forerunner of our modern instruments. (See Figure 4)


MICROGRAPHIA.

probably there might be a way found out, to make an artificial glutinous composition, much resembling, if not full as good, nay better, than that wire-drawn by this excellent Insect.

Figure 1
Page 7 of Robert Hooke's book Micrographia published in 1665 in which he predicts the birth of synthetic fibers

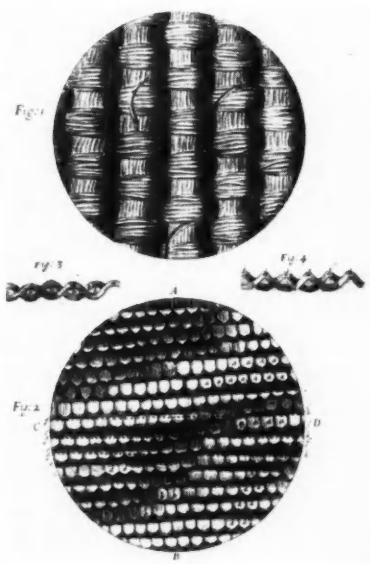


Figure 2
The first textile micrographs by Robert Hooke. Above, lawn, and below is watered silk from Virginia

It is interesting to note, that in addition to the many fundamental microscopical observations in the book, there are also presented many ingenious ideas which have helped in the development of several other sciences. Hooke's views on combustion were the first modern ideas on the subject. In this book he presents the conception that heat is a mode of motion and that light is a vibratory motion. He discusses the phenomenon of "Newton's Rings" and the behavior of liquids in capillary tubes. New inventions concerning the microscope, the hygrometer and telescopes are presented.

While "Micrographia" has carved for itself a great place in the history of science, the author himself is almost unknown. Many of his contemporaries, such as Newton, Boyle and Wren, however, are universally known. Perhaps the neglect of Hooke has been due to the fact that he did so many things that his name never became coupled with a single field of work or with one basic idea. Also, perhaps, the diversity of his work and his unappealing personality have driven off prospective biographers. Finally, pictures or sketches of the man which might help to fix his image in our minds are nonexistant. Nevertheless Robert Hooke was one of the greatest scientists ever produced by England. His life is intimately connected with the Royal Society, which he served for many years as curator; with Robert Boyle, whom he served for many years as assistant and trusted friend; and with Newton, with whom he had many controversies over scientific priorities.

Robert Hooke was born on the Isle of Wight on July 18, 1635. As a youth he was sickly, and in fact, was in poor health most of his life. Hooke was sent to Christ College, Oxford, and while there became assistant to Robert Boyle. The great turning point in Hooke's life occurred in November, 1662, when in the words of the Society's early records "Sir Robert Morey proposed a person that was willing to be entertained as a curator by the Society offering to furnish them every day when they met with three or four considerable experiments; which proposition was unanimously received, Mr Hooke being named to be the person; and accordingly the next day at their meeting on the 12th of November he was unanimously accepted with the thanks of the Society, ordered to Mr Boyle for dispensing with him for their use, and ordered that Mr Hooke come and sit among them and both bring in every day three or four of his experiments and

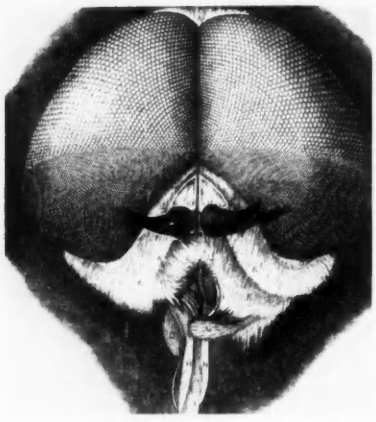


Figure 3
Drawing by Robert Hooke of "the eyes and head of a grey drone-fly" as seen by him through his microscope. He said he made this choice of subjects over that of the great blue-fly because "I found this fly to have, first the biggest clusters of eyes in proportion to his head . . ."

take care of such others as should be recommended to him by the Society." From that time on almost until his death in March, 1702, the name of Hooke and that of the Royal Society were almost synonymous.

Hooke never married and lived a rather lonely personal life. He was reputed to be miserly and rather cynical. His only interest in life seemed to be science and experimentation although, after the Great London Fire, he acted as a surveyor for the city and amassed a considerable sum of money, which was found at his death locked up in an iron chest.

Besides those in "Micrographia", Hooke's inventions run into the hundreds. He invented the watch hair spring, and suggested the use of zero as the freezing point of the thermometer. The famous air pump, which the less practical Robert Boyle used for the discovery of "Boyle's Law", was built by Robert Hooke. This instrument really was the grandparent of the steam engine of James Watt, the "progenitor of the greater triumphs of industrial England." His law of elasticity, known as Hooke's Law, is studied by almost every schoolboy. Hooke's work in the field of gravitation even predated that of Newton.

In the final sentence on page 7 of "Micrographia", Hooke, in speaking of his prediction on synthetic fibers says,

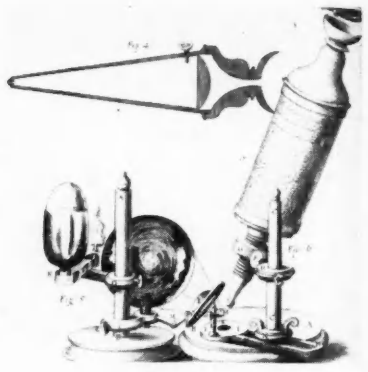


Figure 4
A drawing by Robert Hooke of the compound microscope which he designed, made and used for many of his micrographs

"This hint, therefore, may, I hope, give some ingenious person an occasion of making some trials which if successful, I have my aim, and I suppose he will have no occasion to be displeased." Surely the great synthetic fiber industry today is the answer to his predictions and dream.

• ABSTRACTS •

Man-Made Fiber Data Sheets: a Comprehensive Method of Identifying and Differentiating between the Chemical Fibers

P A Koch, *Modern Textiles* 35, 36, 42-6, January, 1954.

The identification of the various types of chemical fibers (i e, with regard to their different basic raw materials or methods of manufacture) is best carried out by using a microscope or by means of chemical or color reactions. Identification by other characteristics, such as specific gravity, swelling phenomena, thermal behavior and melting point, detection of certain elements or compounds, luminescence, and behavior on burning, is either more complicated as regards the method of testing or less reliable.

Microscopically, the structures of the chemical fibers in longitudinal view are less varied than those of the natural fibers. They appear, in general, more or less strongly striated, corresponding to lobed, milled, or toothed forms of cross-section. An approximately circular cross-section appears completely structureless longitudinally. Differentiation of the individual types of chemical fibers by the usual longitudinal microscopic view is therefore impossible, and an examination of their *cross-sectional form* becomes necessary. In most cases, any one of the so-called quick methods for the preparation of a cross-section is satisfactory.

The author gives instructions for cutting the cross-sections, and shows photomicrographs, all at magnification 250x, of cross-sections of a large number of man-made fibers.

The "Type Reactions" table, which is included, gives simple reactions to differentiate between the cellulosic, alginic, protein, polyacrylic, polyester and polyamide types. A "Burning Test" applied to each fiber is also tabulated. A "Chemical Determination" table, in which various acids, solvents, and stains are used, completes the identification of the individual fibers.

A bibliography of ten references to the literature is included.—WHC

Cotton and the Synthetic Fibers

G S Buck, Jr, *Papers Am Assoc Textile Technol* 9, 9-16, December, 1953.

It is impossible today to discuss realistically the position of any fiber, natural or synthetic, without taking into account the influence upon it of other members of the now considerable textile fiber family.

There can be no question about the existence of inter-fiber competition today. Nylon's replacement of silk in women's hosiery, rayon's progress in the tire cord market formerly held by cotton, and the dilutions and substitutions with synthetic fibers which have limited the expansion of wool in many uses are just a few examples.

The factors which affect interfiber competition, aside from the very important influence of promotion, are price and performance. Thus far only rayon and acetate, among the synthetic fibers, compete with cotton on a price basis. The costs of cotton production must be reduced if cotton is to remain competitive.

In some areas land preparation, planting, cultivation, and harvesting of cotton are now completely mechanized. Machines harvest more cotton each year. Five years ago less than 1% of the cotton crop was harvested mechanically. Last year an estimated 16% was machine harvested. This year there will be enough machines available to harvest 30% of the crop.

At the same time production per acre has increased in the last 25 years for the Cotton Belt as a whole from 165 to 285 lbs. Chemical control of insects and weeds is gaining, fertilization methods are improving, and even the leaves of the cotton plant are removed by chemicals prior to mechanical harvesting. Naturally lower costs have resulted for those producing units where the principles of mechanization have been fully applied.

To a large extent, the newer synthetic

fibers are competing with cotton as specialists, rather than as general purpose fibers. A fire-resistant fiber may fill one need, a mildew-resistant fiber a second, and a fiber which does not absorb moisture a third. The versatility of a synthetic fiber may also be extended somewhat by changes in the physical or chemical characteristics of a given fiber type. In other words, instead of a single nylon, one may have several different nylons, giving a range of elastic characteristics and other properties which make the whole family more widely applicable. However, each nylon type will still remain a specialist.

The author discusses blends of cotton with other fibers, and points out that essentially fiber blending is done to increase the versatility or range of functional properties of a textile fabric. Blending overcomes fiber deficiencies. A non-absorbent fiber is blended with an absorbent fiber to yield a fabric having the properties of moisture-absorption and transmission necessary for comfort in clothing. A strong fiber is blended with a weaker fiber to raise yarn and fabric strength. A resilient fiber is combined with one having poor wrinkle-resistance. His conclusion is that the synthetic fibers have something to gain from blending, but that cotton, on the other hand, can derive relatively little from blends.

Cotton can best achieve specialized properties, where the use requirements demand them, by physical or chemical modifications of the fiber itself. Most of the known chemical modifications of cotton are achieved by reaction with the hydroxyl groups of the cellulose; e g, acetylation and cyanoethylation, which provide mildew and heat resistance.

The author also cites various finishes for cotton which change its properties (mercerization, waterproofing with Zelan, use of resins for crease-resistance, etc). He concludes that chemistry may offer more favorable opportunities for the development of specialized cottons than for the introduction of new synthetic fibers.—WHC

The Use of Microscopy in Textile Dyeing and Finishing

G G Taylor and J C Brown, *J Soc Dyers Colourists* 69, 396-403, November, 1953.

The object of this paper is to review the application of microscopy to the study of textile fibers. A brief exposition is given of the best methods of mounting and examining various fibers, and the application of the techniques of polarized light, staining, and microtomy is discussed. Recent advances in the histology of protein fibers due to both visual and electron microscopy are described, and the more useful microscopic tests for protein fiber damage are covered. The structure of the natural cellulosic fibers, cotton and linen, is discussed, and the microscopical detection of chemical modifications of cellulose is described. An outline is given of some staining experiments which have a bearing on the structure of regenerated cellulosic fibers.

The use of Polaroid sheet in place of Nicol prisms is recommended by the authors as a distinct economy. Ektachrome B (Kodak) sheet film was used for the interesting colored photomicrographs of various fibers that are shown, some stained and some viewed under polarized light.

The paper contains many useful suggestions, and should be read in its entirety. Fifty-seven references to the literature are cited.—WHC

Silicones Applied in Textile Processing

Schweiger, *Melliand Textilber*, 344-5 (April, 1953); 543-5 (June, 1953)

The results of tests using silicones for finishing textiles are reported in this article. The main purpose of the testing was to determine how well commercial silicone brands, such as "WS-60" and DeCetex 104, compare with customary hydrophobing products, such as Hydrophobol WF (a wax emulsion), in their hydrophobing effect, especially on cotton fabrics.

One portion of material was padded with emulsions of silicones in a 3-roller mangle with a pick up of 90%, dried at room temperature, and baked at 120°C. Another portion of the same material was padded with the wax-emulsion composition at 40°C and then dried in the same manner; condensation at elevated temperatures was omitted in this case. The dried specimens were conditioned at 65% relative humidity for 3 hours, sprayed for 3 minutes under equal water pressure, and further washed with 0.3% Marseille soap solution in Permutit-treated water at 35°C for 15 minutes. The author reports that the silicone finishes produced "interesting" results insofar as fastness to washing is concerned; "Hydrophobol" proved to be superior in regard to water repellency, according to the spray test. It is pointed out, however, that the silicone brands used were developed for synthetic fibers.

Other sections of the article discuss comparative tests of air permeability, drying conditions, tensile strength, and fastness to rubbing and light.

General conclusions regarding the performance of silicones, however, cannot be drawn from these comparative laboratory tests and further research in this field appears to be advisable.—(In German)—PW

The "Colloresin" Printing Method

Bernardy and Küppers, *Melliand Textilber*, 443-5 (May, 1953); 538-42 (June, 1953)

The method known as Colloresin printing, which consists of printing a vat dye thickened with an alkali-coagulant gum and fixing by passing through alkaline hydrosulfite solution, was developed by Pfeffer in 1925. Many thickeners that are hardenable in alkaline media can be used and are described in some patents, but practically only Carob Bean Gum or methylcellulose ("Colloresin D") have been used. The method is relatively simple and does not require expensive equipment. The printing pastes are stable; drying and developing by steam is no problem. The Colloresin method is particularly useful for screen printing, but it may be applied as well in rollers, block and warp printing.

Several preparations of Carob Bean Gum ("Diagum", "Ceratonia Gum", "Polygum" etc) are on the market. The flour of tamarind seed is used for the same purpose, especially in England. Cellulose ether preparations are also used under the name "Tylose".

Formulations for thickening pastes are offered by the authors as well as detailed suggestions for drying initially after printing and again after impregnating with the alkaline reducing agent, for aging and developing, for two-tone and resist effects, and so on. According to the authors, application of this method, which is used mainly in screen and block printing, might be very interesting for other printing methods because of ease of handling, storing and aging the printed goods.—(In German)—PW

Everglaze Chintz and Embossing Effects

Bodmer, *Melliand Textilber*, 450-1 (May, 1953)

The author discusses Joseph Bancroft & Son's "Everglaze" process for producing durable embossing and calendering finishes, based on the use of urea or melamine precondensates.

The characteristic procedure quite generally comprises padding with hardenable resin precondensates and curing to fix the effect, but it is essential to keep the optimum conditions throughout, especially the strictly controlled temperatures, to avoid premature condensation. Special formulas and new calender equipment had to be developed. Companies licensed to apply the Everglaze method (nine plants in Germany) are permitted to affix the corresponding label to their goods only when they are finished under strictly controlled conditions. Samples of various combined gauffrage printing and embossing effects are presented—(In German)—PW

The Development and End Uses of "Orlon"

R W Trapnell, *Canadian Textile J* 70, 59-62, December 4, 1953

Orlon is a relatively new fiber, and though much development work has been carried out, in many cases the markets for this fiber have not yet been clearly defined.

The original Orlon, Type 41, was composed of 100 per cent acrylonitrile. It was stock- and top-dyed very satisfactorily, but piece-dyeing was difficult and expensive. In March, 1953, the production of Type 42 was begun. This is a modified acrylic fiber with improved dyeability, which can be union-dyed with wool, rayon, acetate, nylon, etc, through the use of a group of newly-developed basic dyes. The fiber can also be dyed in light shades with acetate dyes.

Orlon staple fiber possesses dimensional stability to washing and dry-cleaning, and when used in the proper percentage it can give these same properties to blends. It also improves the wrinkle-recovery of various constructions.

The staple fiber is being largely used for knit goods, particularly sweaters (100 percent Orlon), and jersey fabrics, usually containing a small amount of wool. Blends of 55 percent Orlon and 45 percent wool are being woven into women's wear fabrics, while men's wear garments usually contain 35 percent Orlon and 65 percent wool.

Blends of Orlon and rayon are being produced for many end uses. As little as 25 percent Orlon will improve the crease retention in men's trousers and other garments. Blends of Orlon and cotton are also making progress, particularly for work clothing.

Filament Orlon is being used in combination with various other fibers, e g, as decorative striping in automotive upholstery. The fiber also finds use in sheer lingerie garments. The filament product, like the staple, makes possible dimensionally stable fabrics.—WHC

Absorptiometric Colorimetry in the Textile Laboratory

C H Giles and I S Shaw, *J Soc Dyers Colourists* 69, 481-91, December, 1953.

This is a description of the principal uses of absorptiometers and colorimeters in a textile laboratory, including their employment for the determination of the concentrations of dyes in solution and of dyes and certain auxiliary products on the fiber, the amounts of metals present on the fiber, and the pH values of aqueous liquids. Recent developments in the understanding of the relative accuracy attainable in absorptiometric analysis, and its improvement, are discussed. The paper is largely a review, but a little new investigational work has been included where necessary to supplement the published information.

Absorptiometric analysis depends on the quantitative comparison of the light-transmission properties of a test sample solution against a standard solution prepared from the same constituents, and of known concentration. Any reagent can be analyzed in this way even if it is not itself colored, provided it can be brought into solution suitably as a colored product. (Colored products here include those absorbing strongly in the near ultraviolet region, because this comes within the range of many modern instruments.) The following three main types of instrument are now in use for the purpose:

Duboscq Colorimeter. An optical device enables the light passing through two cells, containing standard solution and test sample respectively, to be compared by eye, and the length of light path through each solution may be varied until a match is obtained.

Photoelectric Absorptiometer. The light transmission of each solution is determined by allowing light to pass through it on to a photoelectric cell and measuring the current so generated. Filters (or a diffraction grating) are used so that light of only the most effective wave-band for the analysis is used. This wave-band is that which covers most closely the maximum wavelength of absorption of the substance under test.

Photoelectric Spectrophotometer. This is a more elaborate instrument than the absorptiometer, the wave-band selection being made by a dispersing prism of glass or quartz, and the spectrum employed usually extending some distance into the ultraviolet and infrared regions.

A table of the absorptiometers and colorimeters manufactured in Great Britain, with details of their various mechanisms, is appended. The principles of operation of the Baird & Tatlock absorptiometer and the Beckman spectrophotometer are also described, with diagrams.

Thirty-two references to the literature are cited.—WHC

The Mechanical Finishing of Cotton and Rayon Fabrics: A New Use for Isocyanates

"Textile Chemist", *Textile Recorder* 71, 135-7, November, 1953.

Recently there has been renewed interest in the application of mechanical finishing treatments to cellulosic fiber fabrics for the production of glazed, lustrous and embossed effects. The essential difference between the old and the new finishes is that, whereas the earlier processing methods were purely mechanical, the fabric being simply led through a lustering or embossing calender, the later methods combine this mechanical processing with a chemical treatment which provides superior fixation of the fabric modification.

In the various attempts which have been made to increase the fastness to water of mechanical finishes, considerable success has been achieved by the use of certain synthetic resins which, because of their thermosetting properties, can be molded under the influence of heat and pressure into a shape or form which they strongly tend to retain after removal of the molding influences. Quite a wide variety of synthetic resins and particularly those based on condensation products of formaldehye with urea, melamine, etc, have been employed in this way.

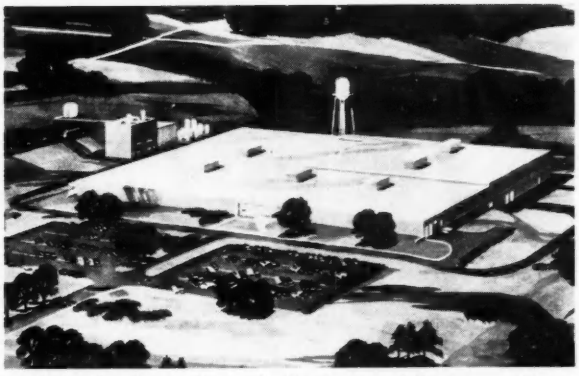
Recently another method has been devised for giving increased permanence to mechanically finished cotton and rayon fabrics (B P 696,029-30). This method makes use of organic isocyanates which are reactive towards such textile fibers as may contain reactive hydroxyl or amino groups.

The author points out that in using a resin to stabilize a mechanical finish, the resin is left within and between the fibers of the fabric, but substantially without chemical combination. It is, in consequence, fairly easy to extract the resin and to leave the fabric in its original form. In using an organic isocyanate, however, a fair degree of chemical combination occurs between this substance and the fibers.

In the new process, the cotton or rayon fabric is first subjected to the mechanical finishing treatment (e g, an embossing calender) and is afterwards impregnated with an organic solution of an organic isocyanate, or of a substance capable of yielding this type of material. A heat or curing treatment follows in which the isocyanate enters into chemical combination with the fibers, fixing them in their finished state and rendering them inert to water. As an alternative, the organic isocyanate may be deposited in the fabric before the mechanical treatment, while in another variation of the process the isocyanate is applied to the fabric before the mechanical treatment in the form of an aqueous dispersion. In this case the fabric is dried and suitably conditioned before being mechanically finished.

The author describes a number of organic isocyanates suitable for this process. He gives full instructions for the application procedure, and explains the chemical reactions involved.—WHC

NEWS



Artist's sketch of Coats & Clark thread-finishing mill at Toccoa, Ga

• New Coats & Clark Mill Nearing Completion

The new multi-million dollar Coats & Clark Inc thread finishing mill in Toccoa, Georgia is nearing completion, and is expected to be in operation by October of this year, less than two years after the project was conceived. It is reported that it not only will have the largest package dyeing facilities but in addition will be the world's biggest thread mercerizer. The new mill will be the firm's eighth installation in Georgia and the second in Toccoa.

The main building contains approximately 350,000 square feet of floor space and covers some 10 acres of ground. Facilities are also provided for a first-aid room, a cafeteria and a large parking field. It is located on a 100-acre tract about 3 miles south of the city proper.

J E Sirrine & Co designed the new mill and the construction is being handled by the Daniel Construction Co. A J Morse, vice-president of Coats & Clark Inc, has been named mill manager.

• New LTI Alumni Chapter Formed

The Pioneer Valley Chapter, a new chapter of the Lowell Technological Institute Alumni Association, has been formed in the Northampton-Holyoke (Connecticut River Valley) area of Massachusetts.

Highlighting the first meeting of the new chapter on March 23rd at the Yankee Pedlar Inn, Holyoke, was a talk by Prof John Lewis, head of LTI's Paper Engineering Dept.

• ALCA Convention

The 1954 Convention of the American Leather Chemists Association will begin with a presidential reception on Sunday, June 6, at the Bedford Spring Hotel, Bedford, Pa, and will continue through June 6. The annual banquet is slated for June 8.

One of the outstanding features of the meeting will be a day devoted to problems of practical tanning. This part of the program will be under the supervision of a committee of representatives from the three Production Clubs.

The Convention Committee consists of Dominic Meo, Salem Oil and Grease Co, *Chairman;* Ralph Nelson, Beggs and Cobb, *Hotel Arrangements;* H Y Miller and Robert Weldon, Seton Leather Co, *Golf;* Mrs Reuben Henrich, *Ladies;* and Lauren Meyers, Pfister and Vogel Tanning Co, *Entertainment.*

• Atlas Powder Sets Up 8 New Scholarships

Atlas Powder Company has set up eight $1,000 college scholarships for science students as part of the company's program to enable outstanding students to complete their scientific education in order to help meet some of industry's pressing needs for technical personnel.

The awards will go to students who will be seniors during the 1954-55 college year, majoring in chemistry, physics or any branch of engineering. The program, initially being proposed to 40 colleges and universities, will be administered by the Atlas committee on scholarships chaired by Thomas Kennedy, the company's director of industrial relations.

• Chemstrand Official Reports No Difficulties in Dyeing Acrilan-Wool Blends

In contrast to the difficulties reported in the dyeing of new fiber-wool blends because of extremely long dyeing times required by multiplicity of dye and scour baths, Walter H Hindle, associate director of research of The Chemstrand Corporation, revealed recently that no such problems are being encountered in the dyeing of Acrilan-wool blends.

This was one of the questions raised at the recent seminar of textile mill operators sponsored by the National Association of Wool Manufacturers in Philadelphia.

One process in current production use, said Mr Hindle, involves the use of acid dyeing premetalized dyestuffs capable of union dyeing Acrilan acrylic fiber and wool by a single-bath process in relatively short dyeing time.

A second technique now under survey and evaluation, he continued, employs dispersed acetate dyestuff for the Acrilan and neutral dyeing premetalized dyestuff for the wool, again by a single-bath method.

Probably the most important factor in reduction of dyeing times, he said, is made possible by the natural affinity of Acrilan for the classes of dyestuff employed without need for carriers. He stated that the elimination of carriers not only simplifies dyeing procedures, but also removes many of the problems inherent in carrier systems, such as high cost, stream pollution, toxicity, solvent bleeding and special handling.

• 17th Summer Refresher Course in Textiles

The United States Testing Company, Inc, has announced the 17th Summer Refresher Course in Textiles and Testing Techniques (s-175) which will be conducted during the second half of the Teachers College Summer Session, Columbia University, July 26 to August 13, 1954. The course will be held at U S Testing's main laboratories in Hoboken, N J. This also marks the fifth year Teachers College has accredited the course for 3 points credit toward a degree. For further information and application forms, write to: Ruth Holmes Little, director, Consumer Service Division, United States Testing Company, Inc, 1415 Park Avenue, Hoboken, N J.

• 53rd Annual PTI Alumni Reunion

The 53rd Annual Alumni Reunion of the Philadelphia Textile Institute will be held Friday, June 11, according to an announcement by reunion chairman Edwin Michie, Andrew Y Cichie & Sons, and Alumni Association president, Edward G Haack, General Dyestuff Corp.

As in the past years, the affair will take place at the Manufacturers Golf and Country Club, Oreland, Pa. All facilities of the Club will be available to the graduates and former students of the Institute and their guests. Annual meeting of the Association will take place in the late morning; included in the order of business will be election of officers for the next year.

Luncheon in the grill will follow, and then the annual golf tournament. For nongolfers, a number of other outdoor and indoor activities will be available.

The day's events will close with the annual Reunion Banquet at 7 PM.

• Du Pont Granted "Taslan" Trade-Mark

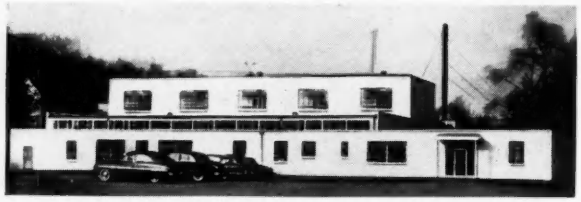
"Taslan" has been adopted as the trademark for textured yarn made by Du Pont's bulking process, a mechanical method of changing the loft, texture, covering power and feel of normal textile yarns.

The mark "Taslan" is available, under certain quality control conditions, to manufacturers who have been licensed by Du Pont to produce textured yarns on the new process.

A development of Du Pont's Textile Fibers Department, the process was announced in June, 1953. Since that time a number of companies have been licensed to produce the yarns. The Du Pont Company has applied for registration of the trade-mark "Taslan" in the United States and many foreign countries. It has applied for patents on the process and the product, but will itself produce only experimental quantities of "Taslan" yarn.

• AOCS Short Course

"Inedible Fats and Fatty Acids" is the subject of the Sixth Short Course to be sponsored by the American Oil Chemists' Society. The course will be held at Lehigh University, Bethlehem, Pennsylvania, August 15-20, 1954. Topics to be included are economic and technological trends, recovery and handling of inedible fats and fatty acids, chemical reactions, technology and applications of inedible glycerines, and production and applications of fatty acids and derivatives. The course is limited to 200. The registration fee for the course is $50; room and board, $35 (Sunday evening to Friday noon). Registration forms can be obtained from the Society's office, 35 E Wacker Drive, Chicago 1, Illinois.



The new Polymer Industries plant opened in Springdale, Conn, reportedly increases the firm's manufacture of industrial adhesives and textile chemicals fifty percent. The new 25,000 square ft facilities consolidate Polymer Industries' former operation in Astoria, L I and Brooklyn, N Y. The new plant is located on a 4-acre site and includes laboratories, warehousing, and administrative areas in addition to manufacturing and packaging.

• AIEE Southern Textile Conference

A two-day conference on the textile industry, sponsored by the American Institute of Electrical Engineers Sub-committee on the Textile Industry, was held at Georgia Institute of Technology, Atlanta, Ga, April 15 and 16.

During the three sessions, new developments in the application of electrical engineering to various aspects of the industry were discussed in eight papers and a panel discussion on mill electrical problems.

The panel discussion took place during the final session, with J D McConnell, Cone Mills, as moderator. Members of the panel included J E McConnville, Minneapolis-Honeywell Regulator Company; J D Stephenson, Westinghouse Electric Corp; W L Roark, Avondale Mills; K A Richardson, Bibb Manufacturing Co; and R C Lathem, Georgia Tech.

• ASTM to Publish Directory of Commercial and College Laboratories

The *Directory of Commercial and Colleg Laboratories,* hitherto compiled and published by the National Bureau of Standards of the U S Department of Commerce, will be published in the future by the American Society for Testing Materials, according to a recent agreement between the two organizations. First published in 1927, the Directory has been periodically revised. It provides interested persons with information concerning the location of testing laboratories together with the types of commodities and the nature of the investigations the laboratories are prepared to undertake.

Until the revised ASTM Directory is completed, the present Directory, *National Bureau of Standards Miscellaneous Publication M187,* published in 1947, will continue to be available from the Superintendent of Documents, Government Printing Office, Washington 25, D C.

• Lab Course in the Electron Microscope

The annual Cornell University Summer Laboratory Course in Techniques and Applications of the Electron Microscope will be given this summer from June 14 to June 26, 1954, by the Laboratory of Electron Microscopy. The course, under the direction of Benjamin M Siegel, will have James Hillier of Melpar, Inc, Alexandria, Va, and C E Hall of MIT, Cambridge, Mass, as guest lecturers this year.

The course is designed for those research workers, institutional and industrial, who have recently entered the field of electron microscopy or who are now planning to undertake research problems involving applications of this instrument. Further inquiries should be addressed to Dr Siegel, Department of Engineering Physics, Rockefeller Hall, Cornell University, Ithaca, N Y.

PERSONNEL NOTES

OLIVER W CASS, assistant laboratory manager of the Du Pont Company's electrochemicals department at Niagara Falls, N Y, has won the 1954 Jacob F Schoellkopf Medal of the American Chemical Society's Western New York Section.

The medal will be presented to Dr Cass at a dinner meeting of the section at the Buffalo Launch Club on May 18.

TEXTILE Research Institute has announced the appointment of JOHN MENKART as director of the work of the Wool Research Project. Dr Menkart, who recently joined the staff of the Institute, has had wide experience in both academic and technological research on wool.